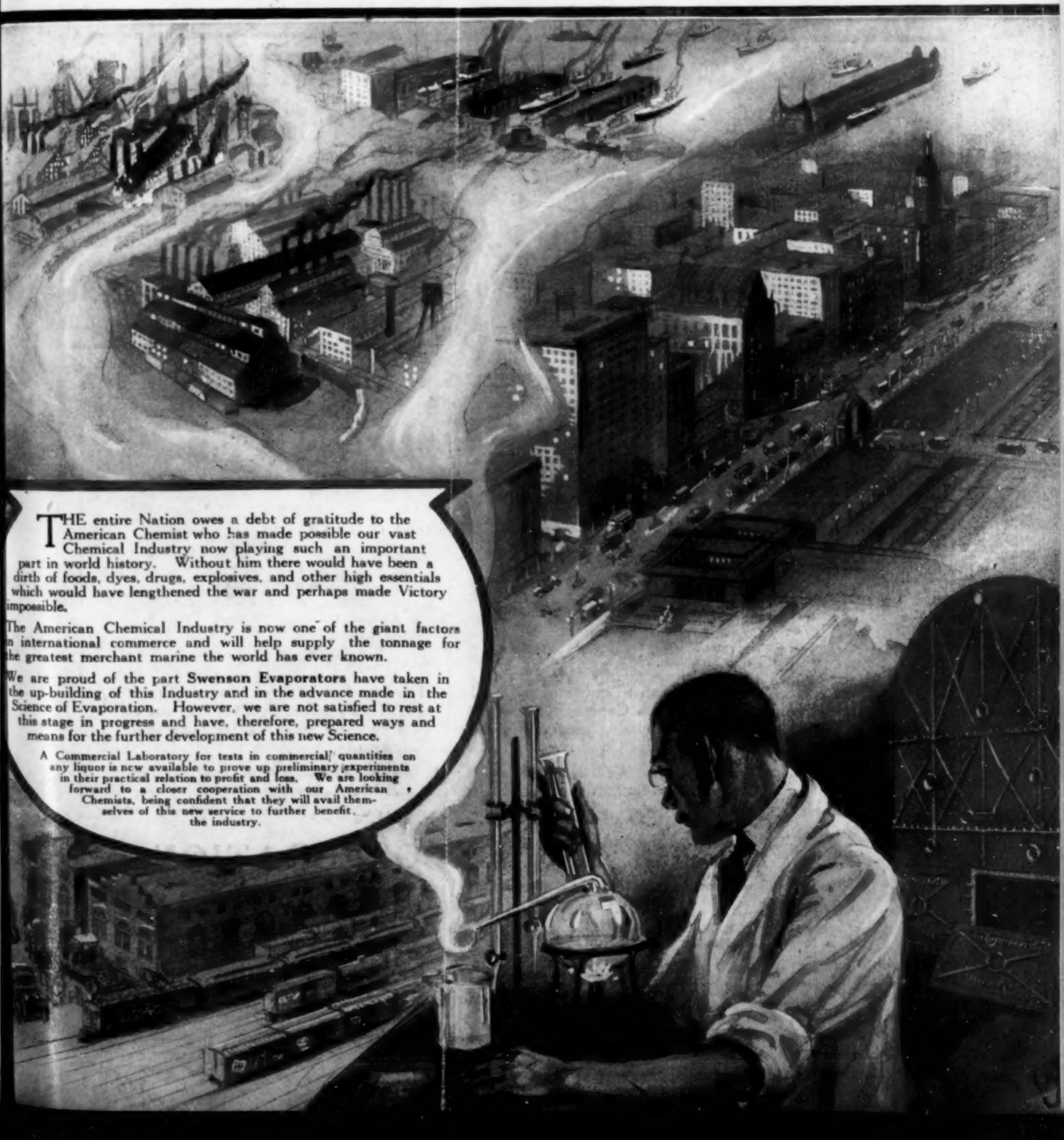
CHEMICAL & METALLURGICAL ENGINEERING

New York, November 15, 1918 McGraw-Hill Company, Inc. Vol. XIX, No. 10 25c a copy



Published SEMI-MONTHLY *on the* FIRST *and* FIFTEENTH *of each month*

CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of ELECTROCHEMICAL & METALLURGICAL INDUSTRY *and* IRON & STEEL MAGAZINE

McGRAW-HILL COMPANY, INC.

Tenth Avenue at 36th Street

NEW YORK

JAMES H. McGRAW, President
ARTHUR J. BALDWIN, Vice President E. J. MEHREN, Vice President
EDWARD CALDWELL, Treasurer JAMES H. McGRAW, JR., Secretary

TELEPHONE 2840 Greeley CABLE ADDRESS, Machinist, New York

WASHINGTON, 1410 H. St., N.W. SALT LAKE CITY, Newhouse Bldg.
CHICAGO, Old Colony Bldg. PHILADELPHIA, Real Estate Trust Bldg.
CLEVELAND, Leader-News Bldg. SAN FRANCISCO, Rialto Bldg.
LONDON, 6 Bouverie St., E. C. 4.

H. C. PARMELEE, Editor
ELLWOOD HENDRICK, Consulting Editor
ERNEST E. THUM, Western Editor
WALLACE SAVAGE, Assistant Editor

J. MALCOLM MUIR, Manager

Yearly Subscription price for United States, Mexico and United States dependencies, $3; all other countries, $4. Single Copy, 25c.

When change of address is ordered, the NEW and the OLD addresses must be given. Notice must be received at least 10 days before change takes place. No back copies for more than three months.

Circulation of this issue 10,300 *copies*

CONTENTS *for* November 15, 1918

Volume 19, *Number* 10

Victory Over Might

IN SECURING an absolute defeat of the Teutonic Powers, we believe that the Allies have extracted the Might from the German banner "Might Is Right." The obligations to the world that the German people have incurred will not be cancelled by their surrender of 5,000 cannon, 2,000 airplanes, 160 submarines and other useless war material in proportion, nor by the payment of gold indemnities. The loss that they shall feel most will be foreign good will, and try as hard as they may, they shall never be able to put warmth into the heart that has chilled.

The predominant characteristic of convicted culprits as reported by the prison welfare worker is the desire of the criminal to make it appear that he is not bad. He shrinks from making a confession of his guilt, though he finds great solace in bearing witness against some one else. Try as they may, the German people will have a difficult time to convince the world that they did not support the aims of their infamous government with heart and soul. The allied army did not merely upset the Hohenzollern autocratic militarism but it subjugated a nation which since the days of Rome has been banding into plundering hordes under the banner of "Might Is Right."

Even in the realm of the chemical industry, the wolf was the foster mother. The work of Ostwald, Haber, Nernst, Fischer, advanced into the chemical realm under the same command, "Vorwärts!" that sent the pillagers into Belgium. It was the "Halt!" by the same voice that caused dyes to be sold in all countries outside of Germany at prices designed to keep for their nitrating equipment all the Might.

Making Blast Furnaces and Steel Works Fit

THE opinion is practically unanimous that for several years of peace, following a war of more than four years' duration, which has made its effects keenly felt in the uttermost parts of the earth, there will be trade expansion and much new construction, with a heavy demand for practically all commodities at remunerative prices. Much has been said of "reconstruction," but if the term be construed narrowly to mean restoration in the war area, the history of the period will probably show reconstruction of business throughout the world as of much more importance commercially. There will be trade expansion everywhere, new ideas leading to new ventures and much construction everywhere. The early idea that capital would be scarce after the war on account of so much destruction of property has yielded to the new conception of what can be done financially by

the immense war loans that have been so readily floated. Just for one illustration, municipalities are likely to employ the Liberty Loan methods with which their men, women and children have become so familiar, for the purpose of floating popular loans for municipal improvements, replacing the hitherto universal practice of the city fathers dealing direct with the bankers.

Before the world really starts at full speed on this work, however, there must necessarily be a period of sweeping readjustments. That is fully recognized, and the only debate to-day is as to the number of months that will be required. In the case of steel, the line of demarcation between the readjustment period and the period of world activity commercially will be drawn with particular sharpness, by reason of the fact that whenever there is a heavy demand for steel the major part of it is going into construction, into works planned by the investor, who must buy at prices bearing the proper relation to the expected returns over a period of years, ranging perhaps from ten to twenty-five, according to the nature of the venture.

Of this period of readjustment the iron and steel industry should not lose one day. It has a very important job immediately ahead of it, in making all its plant facilities, its blast furnaces, steel works and rolling mills altogether fit for the work ahead of them. Many are quite unfit now. For fully three years the productive capacity of the American iron and steel industry has been taxed. For about two years it was merely taxed in an ordinary commercial way. The industry was engaged in selling, producing and making money. For nearly a year past its governing motive has been a higher one. The War Industries Board has insisted continuously on maximum production as a patriotic duty, never mind how expensive the operations or how uneconomical some practices might be, if only they assured additional tonnage of steel to meet the great emergency. First there was the damage to plant facilities that always occurs when operations are profitable, the cost being counted and considered warranted, and then there was the extra damage, when the cost in dollars was not counted.

In the first place, all this damage must be repaired and all facilities put in the best condition. In the second place, there has been a sweeping rearrangement in the relative importance of different items of cost, whereby the cost of plant facilities does not bear the same relation to operating cost as formerly obtained. With high wage rates, labor saving machinery is indicated in many places where it was not formerly indicated. Again, under the stress of demand for the last possible ton of steel, capital expenditures have been made with a view of increasing tonnage output rather than reducing cost per ton. The former continuous progress toward more and more economical methods of production has been very largely interrupted. With its greatly increased tonnage capacity the industry must now be much more concerned with capital expenditures that will reduce cost of production than with those that contemplate merely an increase in tonnage. Again, while the iron and steel industry has never had all the capital its engineers and metallurgists desired to invest, it is better provided with capital than ever before as a result of several years of unusual profits. Thus the industry finds itself in an entirely new set of conditions.

The big job thus indicated as lying before the iron and steel industry is one that must be done quickly if it is to be done to the best advantage. The chief time for it is the interim period, of uncertain duration, between the heavy demand for product that has hitherto existed and the heavy demand that is to come when trade has found its stable basis for a period of years of general activity. While the investor in construction work that requires steel may wait until costs find their level, the producer of steel cannot keep him company, for he cannot revamp his works and produce maximum tonnage at the same time.

Commercial Bribery— Trade Commission Acts

THE FEDERAL Trade Commission on October 24 ordered the firm of John F. Buckie & Son, makers of printers' rollers, Chicago, to discontinue the practice of giving gratuities or presents to employees of their customers or to those of competitors' customers, with a view to influencing the purchase of supplies. Another concern was cited to appear before the Commission on December 6 to answer an allegation to the effect that it had been practicing commercial bribery in the sale of its dyestuffs.

This sort of thing must stop. The greatest of our coal-tar dye concerns has taken the firm stand that no bribery shall be practiced and we understand that the leading houses in the industry are following suit. Before the war the bribery of dyers in the color industry was nothing less than outrageous. We have already quoted a remark of a veteran of the dye business which we shall repeat. "Everybody did it," said he, "and the only difference between the Americans and the Germans was that the Americans knew it was wrong and the Germans didn't." He is a man of charitable mind, but perhaps he was right. The point that we want to make is that the practice is too corrupting to allow anybody to engage in it. The penalty has been made severe, but that will not stop it unless there is an enlightened and honest public opinion to back up the law.

We recall one cheerful old hypocrite who sent handsome sums to the persons he would bribe with the memorandum that the remittances were for pew rent, and he soothed his gravelly conscience with the observation that there was nothing wrong in inducing people to go to church. He was not in the chemical trade, we are glad to say. The legend is also told of a late philanthropist who lived his bespangled days in red hot affluence that early in his career it was his occasional habit to send his card in to the railway officials to whom he desired to make sales, accompanied by a sealed envelope. The latter contained the half of a thousand dollar bill that has been torn in two, and with it he gave the message that he had with him the answer to the letter. The answer, of course, was the other half of the bill. This seems hazardous, but he knew his trade.

There is a great element of sport in crime, which is its chief appeal to some minds. And there is humor in it, as there is in most adventure. But it is expensive, viciously expensive to the general welfare. Bribery in trade is also like cheating at cards in that it indicates a fault in him who practices it that renders him unfit to associate with those who do not cheat. Bribery

is a disease, whether it comes through the front door or the back, and it soon spreads itself, no matter how great the effort to hide it.

There are some puling, whining polyps that do not ask for bribes out and out, but always and forever intimate that if they only had certain advantages they could do a great deal for the man with goods for sale. They beat all around the bush with the mumble that they don't want anything but what is right—and then they begin all over again and go on to tell how trustworthy they are keeping secrets. They might also be called the mosquitoes of business. If somebody were to spit upon them they would drown.

Employment Managers and the Wage Earners

WE PRINT elsewhere an article by Mr. C. T. CLAYTON, Director, Training and Dilution Service, United States Department of Labor, on "Who and What Is the Employment Manager?" It is propaganda sent out by the War Industries Board with a view to avoiding after-the-war disorder. When we bear in mind that some twelve million men and women are now engaged in the production and distribution of war supplies, it stands to reason that the transfer, in the main, of so vast an industrial army to the arts of peace calls for intelligence, caution and character. Even more serious will be the placing of returned soldiers.

We are persuaded that the art of employment must receive more intelligent attention hereafter in industry than it has received heretofore. To aid in this the Employment Management Section of the War Industries Board has provided courses of instruction at certain institutions of learning to which employers may send accredited representatives for the purpose of informing themselves on such theory and recorded practice as is available on the subject. The courses run from six weeks to two months and are conducted under the auspices of the Departments of Labor, War and Navy, the United States Shipping Board and the Chamber of Commerce of the United States. Tuition is free.

As industry has grown bulky as well as great, employers of thousands have not thought to urge their men to read as well as to think, although this is done in the Army. Nevertheless industrial workers have read and thought, and they have reached some amazing conclusions, among which is the dictum that life, in nearly all of its aspects, is a problem in economics. The standardized socialist will quote statistics and figures to prove this until any one unfamiliar with his arguments becomes bewildered. And yet it is no strain upon the mind to grasp the idea that there is far more than economics in the business of living. One trouble is, though, that clear thinking is hardly possible when conditions are unfavorable, and unfavorable conditions often obtain in industrial life.

Where poverty pinches life *is* a problem of economics. We mustn't forget that. On the other hand, as soon as decent living conditions arise, economics in a personal sense becomes but a function of sanity, while taste and habit play more important parts. Psychologists say that if a statement is made to a child constantly and repeated without contradiction, by the time he grows up he is likely to regard the statement as a fact, no matter how absurd it may be. Now a surprisingly large number of factory hands have grown up under the constant iteration and reiteration that life is wholly a problem in economics, and we have to meet this illusion almost as an *idée fixe* time and again. Carried to its ultimate conclusion and without the development of taste and the cultivation of habit it leads to anarchy, riot and Bolshevik terror. But the idea is exceedingly popular and, we repeat, when poverty pinches it is right; then economics becomes a question of life or death.

Deputy sheriffs do not cure the illusion. Neither will overpayment of wages, and letting it go at that. We have long emphasized the fact that the feeble minded drift naturally into industry and that labor organizations that carry them as equals do so to their great detriment. According to a Government publication, from five to fifteen per cent of all applicants for jobs in industry are feeble minded. Give them more than a hundred dollars and you are buying trouble.

Industrial obligations are not fulfilled by the payment of wages. They are not even completed by good housing conditions. Something more is required, and that is the development of an enthusiastic, loyal, intelligent working staff. If an industrial organization degrades the quality of citizenship of its workers and by its own fault or neglect permits a situation to arise whereby their progeny become crippled in mind or wayward, the country is better off without that establishment. We cannot afford to make bad Americans, either directly or indirectly, whether the parents be born here or in Italy or Russia or anywhere else. Our boys are fighting nobly for us; we mustn't spoil their land or their people, now or at any other time.

We have no specific cure to recommend. Sometimes a bonus system works and sometimes it doesn't. Sometimes an employment manager is a great help and sometimes he is an ass. The point we want to make is that the workers in an industrial establishment are citizens, real or prospective. We live in a democracy. It is the measure of their intelligence which in the end will guide our country. The responsibility for their development in mind and understanding and in the art of living is a big and solemn thing. We know an otherwise excellent man engaged in industry who misses this point. The more he prospers the worse it is for his home town.

Pure and Applied Chemistry in England

WE PRINT elsewhere the presidential address of Professor WILLIAM JACKSON POPE before the Chemical Society of England, and we commend it to our readers for its sound doctrine, clear vision and its happy grace of expression. The situation of pure and applied chemistry in England in 1914 was not exactly the same as it was in America but in a way we were all in the same boat. We listened devoutly to the siren voices of German privy councillors, professors, consular agents and commercial travelers who sang in chorus the refrain that chemistry cannot thrive outside of Germany. We lacked the training, the scholarship, the precision of thought and habit and every requisite quality to practice chemistry in its refinements, they declared—and we listened attentively without calling their bluff.

We congratulate the Chemical Society on the happy selection of its president and we wish it all success under his guidance.

Readers' Views and Comments

Measuring Odors

To the Editor of Chemical & Metallurgical Engineering

SIR:—In commenting on the paper of V. C. Allison and S. H. Katz, you say, on page 549 of the October 1 issue of CHEMICAL & METALLURGICAL ENGINEERING: "So far as we are aware, this is the first instrument designed to establish olfactory standards, and we sincerely hope that studies on the subject may be continued." Unfortunately for the glory of our American chemists, Allison and Katz have been anticipated by a Hollander, Professor H. Zwaardemaker of the Physiological Laboratory at Utrecht, who not only has designed an instrument for a similar purpose but has obtained a whole series of results of far-reaching significance by its use. A popular, although quite comprehensive, exposition of this field is given by Professor Zwaardemaker[1] himself, while another clear statement of these researches will be found in a general article by J. Larguier des Bancels.[2]

In passing, attention may be drawn to the fact that the word "odormeter" adopted by Allison and Katz hardly corresponds to the best English usage. Should it not be either "odorimeter" or odorometer"? I have seen the assertion[3] that Zwaardemaker speaks of "olfactometry" when measuring the sensitiveness of the sense of smell, and of "odorimetry" in determining the intensity of odors, although my impression is that he has given up the latter term, using the olfactometer for both purposes. Before leaving the subject of Zwaardemaker's work, I wish to draw attention to the Utrecht dissertation of J. Hermanides (1909), which contains extremely important information on an interesting phase of the work resulting from the application of the olfactometer in Zwaardemaker's laboratory. I have not been able to find this pamphlet in the larger Chicago and New York libraries, and would appreciate any hint helping me to locate a copy.

The latter part of your comment, wherein you express the sincere hope that the work may be continued, must receive a most hearty second from all American chemists, for there is surprisingly little being done in this promising field of the relation between chemical constitution and odor.[4] To illustrate that interest in this subject is not altogether dormant, attention may be drawn to the following free translations from the only book that claims to treat the matter.[5] In the preface, Cohn writes:

"A knowledge of the nature of perfumes, their physical, chemical and physiological properties, is a necessary preliminary for their synthesis. Too much attention cannot be paid to this subject, if for no other reason than the desire that German science may assert its preëminence in this field also of chemical activity." Again, on page 64: "The investigation of perfumes, the determination of their constitution and their synthesis, has made the most progress in Germany, because here strictly scientific principles and not empiricism has been the guide. Not without reason do the French see in this successful co-operation of science and industry in Germany a serious threat to the existence of their own industry."

Personally I believe the subject of smell and odors will eventually be of great significance to chemical science and industry and that it will attain an importance transcending even the goal sought by far-sighted chemists in the line of synthetic perfumes; it is therefore a matter of satisfaction to see American chemists doing good work in this neglected field. In closing allow me to compliment the member of your staff who is so alert as to recognize important work and who acts on his judgment in urging its continuance.

V. H. GOTTSCHALK.

Director of Research, American Cotton Oil Co. and subsidiaries. Chicago, Ill.

[1] Ladenburg, "Handwoerterbuch der Naturwissenschaften," Band IV, pp. 967-975 (G. Fischer, Jena, 1913).

[2] "L'Odorat; Revue generale et critique," Archives de Psychologie, X, 1-46 (1910).

[3] Schimmel's Semi-Annual Reports, English edition, October-November, 1904, pp. 104-109.

[4] Gertrud Woker, "The Relations Between Structure and Smell in Organic Compounds," Journ. Phys. Chem., X 455-473 (1906), is probably the only contribution in an American scientific journal in this field.

[5] Georg Cohn, "Die Riechstoffe," in Bolley's "Technologie," VI 2 (Braunschweig, F. Vieweg und Sohn, 1904).

Copper in Converter Slags

To the Editor of Chemical & Metallurgical Engineering

SIR:—Your editorial of April 15 and Mr. Forest Rutherford's letter in your issue of July 15 lead me to give some of my own observations on the behavior and composition of converter slags.

Mr. Rutherford's experiments confirm my belief that it is impossible thoroughly to clean converter slag by pouring it into blast-furnace settlers. This practice would scarcely have gained any popularity did not the great dilution with furnace slag mask the true losses.

Some years ago I determined the copper as sulphide and oxide or silicate in an average sample of converter slag made during a considerable period at a large smelter. These were 0.48 per cent and 1.44 per cent, respectively, showing that 75 per cent of the total copper existed in the oxidized condition, although there was 1.70 per cent sulphur in the slag, more than enough to combine with all the copper present. This shows clearly why settling alone does not produce clean slags. If this slag were poured into a blast-furnace settler a little of the oxide might be reduced by contact with the matte, but surely not a large proportion of it.

Mr. Rutherford evidently believes "that converter slags cannot be cleaned without resmelting them, and in doing so, changing the chemical composition." If by "composition" he refers to the combination in which copper exists in the slag he is evidently right, but if to the relative proportions of silica, iron oxide and other bases, I believe he is only partly so. In support of this I shall quote the results of experiments by Mr. John W. James (*Eng. and Min. Journal*, vol. 97, p. 1114).

Mr. James passed into a reverberatory furnace converter slag which by settling had been reduced in copper content to 1.25-1.50 per cent. By a treatment with green poles and charcoal 40 per cent of the

copper was reduced. He then threw in a little pyrite and brought the copper down in a few minutes to about 0.4 per cent, a normal loss in reverberatory smelting. He concluded that the copper was present in the oxidized condition, and thought there was insufficient sulphur in the slag to combine with all the copper. He suggested that where iron flux was not required the treatment with pyrite would be a satisfactory solution of the problem.

Where converter slag is treated in reverberatory furnaces it is usually charged with roasted or raw concentrates, or both. A fair reduction is sometimes obtained in this way, but I would suggest the addition of pyrite in large lumps as being preferable. These would sink to the bottom and lose half their sulphur by heat alone, the vapor of sulphur rising through the supernatant slag and having an excellent opportunity of reducing the oxide of copper. If siliceous and calcareous ores were available these could of course be added to advantage, but I believe the reduction with pyrite is the essential thing, and no great change in chemical composition would be necessary to produce a satisfactorily clean slag.

Even when smelted in a blast furnace, converter slags are responsible for increasing the copper content of the furnace slag to some extent, both by increasing its specific gravity and consequently hindering the separation of matte and slag, and by introducing oxidized copper. Direct determination of oxidized copper in furnace slags has shown that this loss increases as the converter slag on the charge is increased. This is similar to, though less than, the increase in slag loss when copper silicate ores are smelted in a blast furnace.

Your editorial raises the broader question: How is copper held in a furnace slag? It is not my wish to go fully into this question, as I have already discussed it in detail. (*Eng. and Min. Journal*, vol. 100, p. 215, 263, 305). But I may state that analyses which I made of blast furnace slags from three large plants showed that from 50 per cent to 75 per cent of their copper was in the oxidized condition. The proportion would probably be lower with a heavy sulphide charge.

Chuquicamata, Chile. FRANK E. LATHE.

Role of Colloids in Chemical Processes

To the Editor of Chemical & Metallurgical Engineering

SIR:—I read with much interest your article on the "Rôle of Colloids in Chemical Processes" and note that in numerous fields colloidal action has been recognized.

Under the heading of "Metallurgy," however, nothing has been said of the relationship of colloid chemistry to the flotation process. Some interesting facts are related under "Soap Manufacturing" and it is queer that the very fact that the flotation process is based solely upon colloidal chemistry actions is not more recognized. Only a few days ago I read an article by Jackson Pierce in the *Mining & Scientific Press* on the action of colloids in the flotation process, based upon the assumption that slimy mineral and gangue represent a colloid; in other words, written with a total ignorance of the actual meaning of colloid chemistry, yet it is beyond all question of doubt that just the same as in the soap industry and in the dye industry definite colloidal actions are recognized and utilized so the flotation process is absolutely fundamentally based upon the formation of colloids from the oils, tars, coal-tar intermediate products and the like used, and it seems too bad that probably the biggest percentage of flotation men are still laboring under the impression that mud in the flotation cell represents the colloids and that the true colloid action in the flotation process is therefore overshadowed and drowned by these mediæval ideas. For over a year I have been writing articles from time to time trying to impress upon the flotation industry the importance of research work in the direction of colloidal chemistry, but so far with little success.

I have installed numerous and expensive devices in my laboratory to test out such colloidal actions and am fully satisfied that colloid chemistry absolutely explains the mystery of the so-called flotation phenomena. I have corresponded with Dr. Fisher, who translated Ostwald's "Lectures on Colloid Chemistry," and he joins me in this opinion.

As you say in your note that such publication is timely, I suggest that you open a discussion on that subject and I shall be glad to enter it with what results I have obtained in my own research work.

Joplin, Mo. A. SCHWARZ.

Reinforced Concrete vs. Salt, Brine and Sea Water

To the Editor Chemical & Metallurgical Engineering

SIR:—In your issue of Oct. 15, 1918, there appears an article by H. J. M. Creighton on the subject "Reinforced Concrete vs. Salt, Brine and Sea Water."

It seems to me Mr. Creighton has drawn conclusions which are scarcely warranted by the facts presented. Without a knowledge of the actual location of the various structures referred to in this paper it is difficult to get at the facts, but it is quite apparent from a careful study of the photographs submitted that at least in many of the cases the structure was either improperly designed or improperly constructed.

The regulations of the Joint Committee on Concrete and Reinforced Concrete and all properly prepared specifications for such work require that the reinforcement shall have a protection of concrete of not less than one inch. The Joint Committee devotes a paragraph in its report to the subject of corrosion of metal reinforcement which reads as follows:

"Tests and experience indicate that steel sufficiently imbedded in good concrete is well protected against corrosion, no matter whether located above or below water level. It is recommended that such protection be not less than one inch in thickness. If the concrete is porous so as to be readily permeable by water, as when the concrete is laid with a very dry consistency, the metal may corrode on account of the presence of moisture and air."

A careful study of photographs 3, 7, 8, 9, 10, 12 and 15 would indicate that the metal did not have one inch of protection, and undoubtedly rusting of the reinforcement and, therefore, cracking of the concrete would have occurred in the presence of moisture, regardless of whether the moisture contained salt, brine or sea water. It would also appear from some of the other photographs that the concrete in several cases was not of the best quality, possibly being porous and thus subjecting the reinforcement to early and undue corrosion.

Chicago, Ill. W. M. KINNEY.

Western Chemical and Metallurgical Field

Manganese In California

SUCCESSFUL prospecting and development of manganese-producing mines have gone on at a remarkable rate since Americans were convinced that they must supply the deficiency of ore formerly supplied by ship from Brazil and elsewhere. Not only is a very considerable quantity of high-grade ore now being produced for direct smelting into high-grade ferromanganese, but much ore is being concentrated to eliminate undesirable silica and other impurities, notably at Philipsburg, Mont., as described in our issue of June 15, 1918.

Ore Dressing Tests

E. A. Hersam has conducted some experiments on ores of the latter class, and the results are given in the University of California Publications in Engineering. The results encourage the author to say that if each ore is studied carefully before large expenditures are made for a treatment plant, there will be found abundant reasons for developing the deposits of low-grade ores at this favorable juncture. It is elsewhere officially reported that more than 200,000 tons of siliceous manganese ores are now developed in the Coast regions alone.

Little of the California ore promises a successful mechanical separation except after fine crushing. The manganese minerals are of low density, often approximating that of the gangue, and slime excessively during crushing. Thus while a clean concentrate can be made on machines acting under the principles of hindered settling, most of the values appear in the slimes of an intermediate grade and are difficult if not impossible to treat. Flotation tests on this material were unpromising in every way. Magnetic tests were most favorable, indicating that about 75 per cent of the manganese may be recovered in marketable grade. On the other hand, electrostatic tests were erratic and unsatisfactory. Very encouraging results resulted from lixiviation tests. For instance, 40-mesh ore was leached with a solution containing 10 per cent sulphuric acid and 10 per cent ferrous sulphate, circulating through a diaphragmed electrolytic cell, operating at 2.5 volts and 100 amperes per square meter. Extraction of the manganese from the ore was satisfactory; the metal was deposited as a hydrated dioxide (80 per cent MnO_2) on the anode, and the acid and reducer continuously regenerated. Certain features of this process have received careful examination, others are under minute investigation. Deposition may attain the rate of 1.62 grains of dioxide per ampere hour, and the cost of the process on a large scale is estimated at $15 per ton of product, exclusive of electrical energy.

Production of Silico-Manganese

In the meantime the Pacific Electro Metals Co.'s plant at Bay Point (briefly described in our issue of Aug. 1, 1918) is reducing siliceous ores to an alloy of iron, silicon and manganese. On account of the very small slag volume produced by their electric furnace, the recovery of manganese is excellent—approximating 90 per cent—and the current efficiency is superior to that when producing ferromanganese. The alloy is not widely known among American steel makers, although it was imported in considerable quantities prior to the war and is favorably regarded by at least one of the largest steel companies. France, England and Sweden have all been producers of this alloy, and are producing in quantity at the present time, while it is thought that it supplies practically all the manganese used by the German steel works. Electric furnacemen are fond of saying that in an alloy, carbon and silicon are mutually exclusive, consequently properly made silicomanganese may contain less than 0.5 per cent carbon, which should make an attractive material for use in the production of low carbon steels and ingot-iron.

Ferromanganese on the Coast

At least three companies are equipped to produce ferromanganese on the Pacific Coast. The Western Reduction Co. of Portland, Ore., has a 700-kw. furnace, the Billroe Alloys Corporation of Tacoma, Wash., a 500-kw. furnace, while the pioneer Noble Electric Steel Co. has been devoting a great deal of attention to ferro-alloys for many months past and has now two 1500-kw. furnaces in operation at Heroult, Cal. The Noble company largely produces its own raw materials; its production of high-grade manganese ore amounts to about 600 tons per month from four mines in Shasta, Tehama and San Luis Obispo counties. Charcoal used for a reducing agent is produced by them in two localities in Mendocino County, one a pit-burning operation, seasonal in character, and the other in beehive kilns, which are continuously operated. Iron ore and fluxing limestone are both quarried from large high-grade deposits near the furnace-plant.

A considerable part of the 70 per cent alloy is consumed in the five open-hearth plants on the Pacific Coast. Since three-quarters of the steel produced in this region is sold directly to the Fleet Corporation, it is apparent that the local production of necessary deoxidizers is an essential war industry. The Noble Steel Co. also produces an 80 per cent grade of ferromanganese, which is shipped east to such plants as have permission to use it from the Ferro-Alloys Board of the Iron and Steel Institute. About 500 tons of alloy are produced monthly, and present indications are that this production can be maintained profitably even after cessation of hostilities.

National Potash Company's Plant Destroyed

During the latter part of September the potash plant of the National Potash Company, situated at Antioch, Nebraska, burned to the ground.

The National Potash Company is one of the "big six" in the Nebraska field as far as resources and plant are concerned. Construction on the plant was started only last November, and it had hardly been tuned up to capacity, due to delays in construction and low water in the lakes. Thus the greatest daily output was approximately 20 tons, and the total production had hardly affected the total for the region when the plant was destroyed. The remaining large producers are the Pioneer Potash Products Co., at Hoffland; the Nebraska Potash Works Co., the American Potash Co. and the Alliance Potash Co., all at Antioch; and the Hord Alkali Products Co., at Lakeside.

War Emergency and Reconstruction Conference to Be Held at Atlantic City

PRELIMINARY plans for the War Emergency and Reconstruction Conference of War Service Committees to be held at Atlantic City Dec. 4, 5 and 6 are announced by the Chamber of Commerce of the United States through the general secretary, Mr. Elliot H. Goodwin.

Reconstruction will be given a prominent place on the program, as it is recognized this subject must be taken up by business men to the end that there may be placed at the command of the Government all available sources of information. The work of reconstruction suggests the creation of a federation of all war service committees that whatever study and planning is carried on may be on behalf of all business. War industries and non-war industries are concerned equally in the determination of reconstruction problems. All European countries already are under way with reconstruction plans.

The Atlantic City conference, a call for which was sent out last week by the War Service Executive Committee of the Chamber of Commerce of the United States, will include four general sessions and numerous group and committee meetings. Into the final session will be brought for final action all the proceedings of the meetings.

There will for four general sessions participated in by all the delegates. On Dec. 4 there will be both morning and afternoon sessions and on Dec. 5 and 6 morning sessions. The Chamber is engaged now in obtaining the best speakers available to discuss among others the following suggestions: reconstruction, industrial relations, raw materials and their control, price control, economic legislation affecting combinations, export and import operations, finance, etc.

The conference will be divided into groups at three sessions, the first to be held on the evening of Dec. 4, the second on the afternoon of Dec. 5 and the third on the evening of the same day. On the evening of Dec. 4 each war service committee will meet with its chairman to consider the problems of reconstruction as they affect that particular industry as well as to take up other problems which the war has demonstrated are vital to industry. On the afternoon of Dec. 5 the war service committees will meet in groups which are related as to their use of basic materials and as to their distribution problems, etc. With these groups will meet the commodity or section chiefs of the War Industries Board.

Related groups will form themselves into ten major groups on the evening of Dec. 5 to take up the question of raw materials, price control and subjects arising from related group meetings. After the general meetings of the committees of the related groups and of the major groups it is hoped there will be presented definite recommendations covering the reconstruction period, with the possibility of creating an executive committee empowered to gather data and to function with industries to meet the many problems that the nation's industries will be called upon to solve with the end of the war.

War Industries Board May Be Reconstruction Agency

By Wingrove Bathon

Washington Representative, McGraw-Hill Company, Inc.

IN CONNECTION with the possibility of a Reconstruction and Readjustment Agency being created by act of Congress, opinion is crystallizing in Washington along the lines that the members of the War Industries Board will most likely be appointed to this work in case the Overman bill, which is an administration measure and which provides for a commission of five members to be appointed by the President, is passed by the present Congress. There is every expectation that this bill will be passed, and the likelihood of its passage has been added to by the defeat for re-election to the Senate of Senator Weeks, who proposed a reconstruction measure which would have created a reconstruction agency composed of members of Congress.

In Washington it is now believed that if the Overman bill is passed President Wilson is likely to name as members of the Reconstruction Commission men like Bernard M. Baruch, chairman of the War Industries Board, and some of his principal associates. It is pointed out in Washington that while Senator Weeks has been defeated his idea of a legislative reconstruction agency has not necessarily died. In other words, it is expected that during the life of the present Congress Senator Weeks' idea will be pushed. But it is also pointed out in Washington that there is every likelihood that if a Congressional reconstruction agency were created, even admitting that the consent of President Wilson to do so could be obtained, the new Congress which takes office March 4 next would likely legislate out of existence, possibly by failing to appropriate money, the creature of the present Democratic Congress. All the present signs in Washington, however, tend to show that the Overman bill will be passed and that the machinery of the War Industries Board will be turned into after-the-war work behind the commission to be appointed under the Overman bill, under the probable leadership of Mr. Baruch as chairman of the new commission.

It is pointed out in Washington that the present agencies of the War Industries Board are in possession of complete data and information concerning the industrial, commercial, financial and transportation resources of the country. For this reason there are many who believe that the War Industries Board is the only agency equipped with machinery and supplied with the necessary information to give suitable guidance to business for after-the war work.

There is no means of ascertaining or predicting what effect the elections of Nov. 5 will have upon business and the necessary reconstruction period to follow the war. It must be borne in mind that a great number of Republicans newly elected to the Senate and the House will not take office until March 4, 1919, when a new Congress will come into existence. There has been much newspaper comment to the effect that if the Republicans gained control of the House and the Senate there would in all likelihood be an extra session of the new Congress early next year at which members elected Nov. 5 would take their seats. It seems, however,

extremely unlikely that a Democratic President would call an extra session of a Republican Congress to deal with business matters such as will be involved in the reconstruction period, and it is almost certain that the present Democratic Congress, in view of the foreign situation, will hold on and remain at work in Washington until the very last minute before March 4.

Since the armistice was signed, members of the War Industries Board, more particularly committees of that board, are announcing in Washington their intention of preparing to return home and get ready for the reconstruction period which they must face in their own businesses. In some respects this attitude, while natural, is greatly to be regretted, according to the best opinion obtainable in Washington, because of the growing belief that the War Industries Board, which has done so much to guide business during the war, is so well fitted to continue to guide business during the reconstruction period.

Address to Society of Chemical Industry*

By Charles E. Sholes

PERHAPS you are as bored as I am to hear public speaking interspersed with stories. But when your committee overruled my protest and selected me to serve as Chairman of the Society of Chemical Industry, I immediately thought of the man up state who went into one of our New York hotels and ordered frogs' legs and got a check at $2 a portion. He was furious and offered to furnish all the frogs' legs the hotel could use for a year at 10 cents a dozen, and a contract was duly signed. But no frogs' legs were ever delivered, and the man from up state finally admitted that he had been "deceived by the noise." I think that your committee was probably "deceived by the noise." However, we are all learning a good bit of discipline these days, and when your committee says "Carry on," there is nothing for me to do but obey.

But I want your help. Certainly organizations of this kind cannot be negative. They are either like a female auxiliary of masculine forces, or they will wield a real influence in making this wounded world whole again and in preparing our industries for the new conditions they must meet hereafter.

I do not believe that we are going to exterminate the German race or disposition. We are going to give them a severe beating, but after it is all over the same old dog will be wagging the same old tail outside the same old door to our markets, and we must see to it that he gets nothing which may be needed by our children. Our captains of industry can do much. You can do much. The Society of Chemical Industry should be an effective means of getting together.

And now may I presume to say a word concerning my recent experience and experiences? On the way to the train on that first day in the uniform of the Service a number of privates and junior officers saluted me, and a companion remarked it, until I explained (as I am very glad always to continue to realize) that it is the uniform, not the man, that is saluted. Also I hope it is only for this reason that when one of our clean American boys clips his heels together and stands very erect and gives this uniform a snappy salute, I always have a sneaking wish to swap clothes and everything else I have for his youth and his opportunity of closer contact with this great race between good and evil.

And speaking of races, a professional runner once told me that the way to win a race was to "run as hard as you damn can—and then harder." Although this war is largely an industrial proposition and industries have been prolific in sacrifices, and I believe in them with all my American brain and blood, some of our best industrial racers got a bad start. They seem to have confused the real meaning of the tax on surplus profits, and I have repeatedly heard men contend for a high price, because "80 per cent of the profit is returned to the Government in taxes." But the facts are that the surplus profit tax is only designed to prevent some such bad behavior as we are trying to stop in Europe.

I am still looking for that officer who wears spurs to keep his feet on his desk. I haven't found him, but I have found the hardest-working lot of men I have ever seen striving earnestly with the biggest business proposition on earth, and accomplishing so much that is commendable that the exceptions and faults should be most readily forgiven.

And I'll tell you a secret—they are the best paid men on earth, because, though they only receive small sums of money, they are infinitely more proud of their jobs than any other group of men I have ever met.

May I take a moment more to ask your interest in some of the "C. P. heroes" of this war, who may be overlooked if you allow it? At a recent Sunday luncheon I met a Captain of Engineers who had just returned from France. He was a red-headed American boy and was one of that bunch that held the Hun with only pick and shovel and revolver for many hours—until many were dead and a few were succored by the Regulars. He told us about the barrage, and how much easier it was for an officer who was walking about and looking after his men than it was for the private who could only hug the bottom of the trench and wait until it was over. When this chap tried to pull a pipe from his kit bag, a soiled and broken cardboard box fell out and spilled a French and American Cross of Valor on the floor.

Some months back a nitric acid plant was shut down for want of men. You all know what a charming job it is to feed nitrate of soda into hot apparatus amid choking fumes during a hot and stifling day or night. The men could get much more agreeable work in the ship yards a few miles away. More and more pay was offered until the rate was extravagant, but no men wanted it. Then the superintendent called a meeting of the men and explained what nitric acid meant in the war program, and asked for volunteers. About five or six men answered, and "carried on," and during the next week they got five more, then that crowd got ten more, and so on. That plant has been running full ever since, and to my mind those chaps are just as deserving of the praise and gratitude of our nation as the man who goes over the top over there.

If I have said anything which any of you do not like, I am sorry. If I have said anything which will help you or others, then I can only add, "Carry on."

*Chemists' Club, Oct. 25, 1918.

Gas Warfare, Both Offensive and Defensive

An Account of the Progress Made in the Development of Gas Warfare Since the First German Attack at Ypres on the Canadians—Lethal and Neutralizing Types of Gases—Containers, Shells, Grenades—Types of Masks

MAJOR H. W. DUDLEY, R.E., of the British-American Anti-Gas Service delivered a lecture on "Gas Warfare, Both Offensive and Defensive" at the first meeting of the season of the New York Section of the Society of Chemical Industry, held at Rumford Hall in the Chemists' Club, Oct. 25, 1918. Major Charles E. Sholes, the honorary chairman, presided.

Major Dudley introduced the subject by saying he had spent some time with American troops in France while they were in contact with British troops, and he took pleasure in saying that he found, without exception, the soldiers of each nation filled with great admiration and respect for those of the other and that the fullest co-operation has existed between the British and American armies in regard to gas warfare.

Although gas warfare is but one year old in the United States, there are already, all over the country, great works established for the production of gas munitions, and all of the many developments brought out here are offered immediately to the British army. He desired to lay special emphasis upon the evidences of good will in this respect that had come before him. Only a short time ago a gentleman engaged in making gas warfare material in this country had written him that he understood the English were having trouble with a certain feature of a necessary process. He added that it had been his good fortune to overcome the difficulty and he offered his entire research and practice to the British Government in the interest of the common cause.

The development of gas warfare has been somewhat like the old game between the armor plate and projectile manufacturers in that it has involved a constant race to get ahead between offensive and defensive. All nations have long known its possibilities, and at the Hague Convention in 1899 it was agreed that poison gas should not be used in war. The Germans broke the convention and delivered their first attack on April 22, 1915. It is interesting to note, however, that whenever any act of extraordinary vileness was perpetrated by the Germans there was likely to be some accompanying propaganda. Thus there appeared an official German communiqué in July of this year, when they expected to succeed, that gas warfare originated with the British Admiral Dundonald. The reference is probably to a British admiral of that name who was born in 1775 and died in 1860, and his entire record in relation to the subject was his caution to his Government that asphyxiating gases could be used in warfare. Again, before they made their first attack there were charges brought in official German army communiqués that the English were using poison gas against German soldiers, claiming that this had been done as early as March 1, 1915. The purpose was evidently to prepare the home conscience as well as that of neutrals for the proposed innovation. The first British gas attack actually did take place in September, 1915, and not before. There is every reason to believe that the Germans now bitterly regret that they ever began it, for it is evident that the morale of their army has suffered under it. Captured letters indicate their genuine fear of it and *Die Vossische Zeitung* has published eloquent jeremiads on the subject. And if they only knew what is now being bottled up for them they would grow even more sore depressed.

Enormous amounts of gas are necessary, which limits the substances which can be used. They must be easily prepared and so plentiful that by constantly threatening the enemy with them his efficiency is impeded.

First Attack with Chlorine

The first attack was with what is called the cloud method, near Ypres on April 22, 1915, with chlorine. It was carried in cylinders containing about 44 lb., and these were provided each with a siphon, extending to the bottom, through which the gas, when liberated, escaped through a valve at the top. The siphon provided for the regularity of escape and the cylinders emptied themselves in about three minutes. They were placed in holes before the trenches and covered over so that they might not be detected. To make the attacks more effective toward the end of 1915 the Germans added about 20 per cent phosgene (carbonyl chloride) to the chlorine.

The method has limitations and has been largely, but not wholly, abandoned. It is effective only under favorable weather conditions with the wind blowing in the right direction and at the desired velocity. To be entirely successful it is necessary that the enemy have defective respirators or none at all, although even with good protection and good discipline there are always some casualties in a cloud attack. The Russians, for instance, once had some 10,000 casualties from a comparatively small amount of gas, due to inadequate preparation. In captured German documents it was recorded that their pioneer gas troops liberated 3600 tons of gas and killed 35,000 men with it. Whether this is true or not, it is well to remember that the behavior of the Canadians in holding the line near Ypres and putting up at least enough defense to keep the Germans back when this kind of warfare was considered unbelievable, when they did not know what it would do to them or whether more was coming or not, and when they had no defense against it, was one of the greatest and bravest achievements in this or any other war, and it undoubtedly saved the Channel ports.

There are not many gases suitable for cloud attacks. A suitable gas must have a low boiling point to force itself out of the cylinders, it must have high density to give it adequate covering quality, and it must be stable. Chemically active gases have been found easy to defend against in cloud attacks, whereas those that are chemically inert present greater difficulties. Referring again to the relation of gas clouds to the wind, Major Dudley recalled that in April, 1916, about a year after their initial effort, the Germans released a cloud against the British in a light easterly breeze. Just as the cloud was formed the wind shifted and blew the gas back over the German trenches and caused them 1500 casualties. There is one little detail that the Germans neglected to provide for in their gas offense: the prevailing winds on the western front are from the west. This inadvertence on their part has not been remedied even to this day. Another difficulty is that whereas high concentration is required, the highest concentration is in the immediate neighborhood of the trenches of the offensive side and, of course, the gas constantly diffuses.

Casualties depend upon the success of the following three elements:

1. Surprise. Cylinders must be put into place secretly and hidden. It is a great help to the enemy to know that a cloud attack is to be launched against him with the next fair wind. Escaping gas also makes a noise and gives an alarm.

2. Penetration of the hostile respiration. This is theoretically possible and can be realized, actually, on a limited scale.

3. Exhaustion of hostile respirators. This is theoretically possible but practically, owing to the enormous quantity of gas required to neutralize the chemical filling of a modern respirator under field conditions, the method of producing casualties is unattainable.

When the high and really (*wirklich*) privy councillors of the All-Highest (of whom Professor Nernst is said to have been a leader in the gas business) discovered that the timorous English and decadent French did not give in to their clouds of terror, the next and obvious thing to do was to fill shells with gas. The first gas-filled shells were employed in an attack against the French on May 15, 1915, which was the second step in gas warfare. With shells a wider range of gases is available. Two main types are in use, of which one is lethal and the other is called "neutralizing," the idea of the second being to hamper the opposing army and to put its men, at all events for the time being, out of action. They began with what are called lachrymators, or tear shells. These cause temporary blindness, among other disqualifications. The first German "T-Stoff" (used in May, 1915) was a mixture of xylyl and benzyl bromides. Another lachrymator was "B-Stoff," or brominated methyl-ethyl-ketone, and still another was "Green T-Stoff, which was a mixture of xylyl bromide and bromacetone. A high concentration of these gases produces nausea and Major Dudley has seen persons made unconscious by it.

Another class of neutralizing, as distinguished from lethal gases, is known as the sternutators, or, as they are commonly called, sneeze gases. German shells of this sort are marked with a blue cross and contain diphenylchlorarsine (a solid), mixed with a high explosive which scatters it in fine particles and causes sneezing and vomiting; the purpose being to make soldiers remove their masks and then follow up the attack with a lethal gas.

Lethal gas shells were marked with a green cross and at first contained monochlormethylchloroformate, which was "improved" by substituting trichlormethylchloroformate, sometimes mixed with phosgene, and this remains the German prime favorite. The mixture is very toxic. Sometimes it produces a delayed action so that men fall down and die a few hours after they have been gassed if they indulge in vigorous exertion.

The "Mustard" Gas

Another discourager of irreverence toward German might and will is an eye, lung and skin irritant which bears a yellow cross upon the shells containing it, and for this reason is called mustard gas. It is a liquid that boils at over 200 deg., has low vapor pressure and is heavier than air. Mustard gas is dichlorethyl sulphide. It has but a faint, garlic-like odor and at first troops were deceived by it. To disguise the odor sometimes a little prussic acid is added and again sometimes trichlormethylchloroformate (or "diphosgene") mixed with chlorpicrin or other lachrymators. One part in 50,000



FIG. 1—A BLACK VEILING BANDAGE HOLDING ABSORBENT COTTON TREATED WITH HYPO OVER THE NOSE. (THE FIRST OFFICIAL BRITISH RESPIRATOR.) FIG. 2—THE P. H. HELMET, HAVING AN EXHALATION VALVE, THE AIR BEING FILTERED THROUGH THE MASK. FIG. 3—ORIGINAL TISSOT, HAVING A FILTER CHAMBER AIR INLET AT EYEPIECES TO PREVENT FOGGING AND AN EXHALATION VALVE



FIG. 4.—BRITISH RESPIRATOR. FIG. 5—AMERICAN RESPIRATOR. FIG. 6—GERMAN LANTERN CAN RESPIRATOR

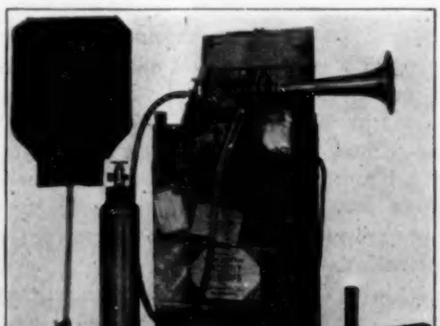
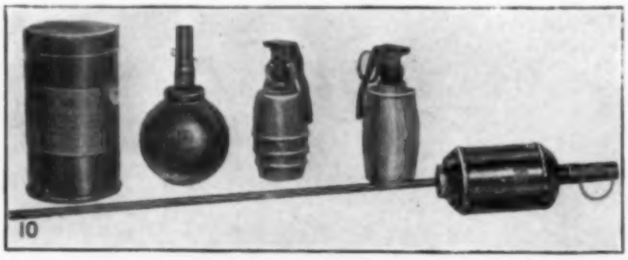
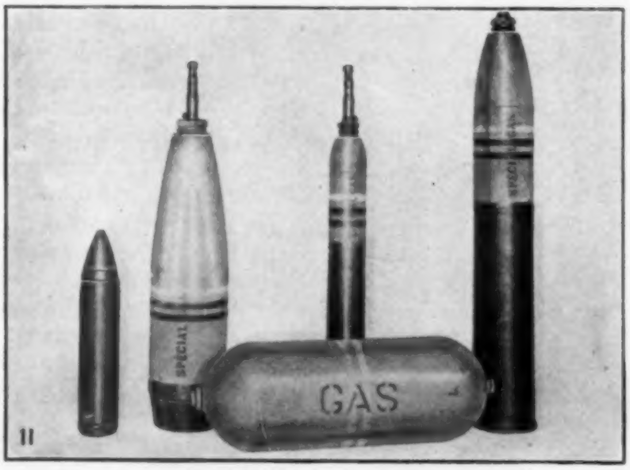




FIG. 7—AMERICAN AND ENGLISH MASKS. FIG. 8—COMPRESSED AIR SIREN, HAND RATTLE AND GAS SHOVEL. FIG. 9—ENGLISH, FRENCH AND GERMAN MASK PACKS

for two minutes will produce severe conjunctivitis, but this is almost the least of its evils. It is a real torture gas because, in addition to its painful effect upon the eyes, it is an intense skin poison, producing sores that easily grow septic and which are in their nature very like burns. Parts of the body that are moist with perspiration are especially susceptible to it and its effects, while not immediate, are sure and put men completely out of action. Men gassed with "mustard" are likely to be attacked under the armpits and in the crotch as well as on the hands, and the effects are exceedingly painful. Still another sequel of this poison is within the lungs, where the same kind of blistering action takes place, with pneumonia and tuberculosis frequently following. Owing to its high boiling point, if the weather is cool and calm it may cover a locality for a week or more. Sometimes again it will be apparently inactive during a cool night, but as soon as the sun





FIGS. 10 AND 11—TYPES OF GAS CONVEYANCES. GRENADES, SHELLS AND BOMBS

shines upon it in the morning it becomes effective. It is used in enormous quantities by the German army and in all sizes of projectiles from a capacity of 300 to 400 cc. to 11 liters.

Hand grenades are in frequent use. They contain smoke producers and toxic gases for cleaning up dugouts. It is a very useful minor weapon, and some are equipped with a device whereby a rod may be attached and the whole shot from a rifle by means of a blank cartridge. They may be called chemical ferrets and are used by the allied armies. It is much safer to throw one into a dugout than to make a personal exploration, and they have been found very persuasive among hiding boches. Later developments provide for firing gas shells of very large capacity from mortars. Gas is not used in aëroplane raids.

In regard to gas defense it should be borne in mind that there wasn't any at the beginning of the war or when the first attacks were made. Fighting with poison gas was one of those things that under agreement was not to be done, and the matter was considered as settled. But it wasn't. All manner of expedients were availed of at first, from handkerchiefs and socks filled with moist earth to anything else that could be thought of. The women of England and France were appealed to and provided the soldiers with respirators in the form of veils enclosing a handful of cotton wool which was dipped in a solution of sodium thiosulphate ("hypo"), sodium carbonate and glycerine immediately before using. Within three days about 1,000,000 such respirators were made in England. In the case of one British army a new respirator was devised and the women in the towns immediately behind the front were requested to make a supply. Material was rushed from Paris by every car available and within a few days those French women had provided 80,000 of the new respirators which were in use in the line of battle. The original veils were reasonably effective against chlorine, but were difficult to operate in the trenches owing to the need of keeping the soaking fluid everywhere convenient. An improvement became imperative as soon as the Germans began to use phosgene.

A respirator should be simple in design and easily adjusted. It is also important that it consist of one piece. The first improvement over the veil was the "hypo helmet," made of flannel, treated with sodium carbonate, sodium thiosulphate and glycerine in solution, and provided with mica windows. The skirt was tucked in under the collar and while it was rather unpleasant to wear it saved many thousands of lives. The next type was called the P. helmet and consisted of a bag made of (cotton) flannelette impregnated with an alkaline solution of sodium phenate. This development was made necessary by the introduction of phosgene into gas warfare. The mica goggles were unsatisfactory and were replaced with glass and a respiratory valve was added through which the breath is exhaled but through which it may not be inhaled. The protection against phosgene was later improved by adding hexamethylene tetramine to the impregnating solution. With these improvements it became known as the P.H. helmet.

Methods of Protection

The introduction of inert gases made an entirely new method of protection necessary, for the flannelette filter was not adequate. This brought about the canister through which the breath is inhaled and blown out through the special valve. In the masks now in use by the British and American armies the nose must be clipped shut, and it goes without saying that the wearing of such a device for any length of time is very uncomfortable. At times, however, it has been necessary for men to wear them for as long as twelve hours at a stretch. The facepieces of rubberized cloth are made full so as to be used to wipe off the interior of the goggles, which become clouded from the wearer's breath.

Strangely enough, although the Germans were the first to use poison gas, they were not prepared to defend themselves against it when it was hurled back at them. Their masks contain a drum of charcoal screwed on before the mouth and both inhalations and exhalations are made through it. The lack of an exhalation valve is

a serious defect, but the drum is a clever device and has been adopted in some American and some French masks. The German facepiece was first made of rubberized cloth but later of softened leather bound with tape, and in the place of rubber bands for adjustment, cloth tubes containing wire springs were used.

Sodium Sulphide and Other Products from Nitre Cake

By H. P. Bassett, Ph. D.

THE disposal of nitre cake, one of our large waste products in the chemical industries of this country, has for many years been a source of much investigation. This waste product from the manufacture of nitric acid has often in the large industries, like the powder companies, been hauled out to sea and dumped, while at inland plants it is buried, when it remains for a considerable length of time, finally leaching away. These two sources of disposal are the ones generally used, as the laws of nearly all our states do not permit it being dumped into the streams, because in many cases the streams furnish water supply for cities; also, it destroys the fish in such streams.

Aside from the difficulty of disposal, there is much value lost in this material, as it contains 30 to 31 per cent free acid besides the sulphuric acid combined as normal sulphate. Of late years considerable amounts of nitre cake have been used in the glass trade and for the separation of iron and nickel, but the normal sulphate is preferred, as the acid sulphate is detrimental to the furnace linings and the free acid given off as sulphur dioxide causes damage to the vegetation.

The normal sulphate can be made from this material by neutralizing with lime and then evaporating the solution of normal sulphate, but considerable amounts of lime or limestone are required, and salt cake made in this manner is expensive and in normal times does not pay the expense incurred. However, the expense in this method may be decreased if special precaution in neutralizing, like a counter-current system, is used and the calcium sulphate obtained in a fair degree of purity, when it would have a market value as a filler for paper, in the cement industry and for many other uses where shipping facilities were adequate.

The second method is to form normal sodium sulphate and either hydrochloric or nitric acid. This can be accomplished at a temperature of red heat and a very high grade sulphate obtained if the material is very intimately mixed and a proper furnace used for carrying out the reaction.

The third method is a unique one and its commercial value would have to be determined. This method consists of mixing the nitre cake with pyrites cinder and roasting the mix at about 600 deg. C., when the free acid is evolved as sulphur trioxide, which can be absorbed in other sulphuric acid to form fuming acid, which commands a good price even in normal times. The cinder from this operation consists of iron oxide and sodium sulphate, and on leaching the sodium sulphate can be recovered.

The two last methods of course have their advantages in that the free acid is used up in making nitric or hydrochloric or sulphuric acids, which are either used by the industries having this material for disposal or in allied industries. They have the disadvantage, however, of probably overloading the market with salt cake, and other avenues would have to be opened up for this material. This salt cake, of course, could be used in the manufacture of sodium carbonate by the Le Blanc process. But again we have a waste material—calcium sulphide—which is as bad as or even worse than the original nitre cake on account of the odor.

The problem finally develops into the disposal of the sodium sulphate or salt cake. A limited amount could be sold to the glass and nickel industries, but a very important market could be found in the sale of sodium sulphate, which can be obtained very economically from this material. This market also has the advantage of growing larger as the supplies become available. The two large uses at present are in the leather trade and in the flotation processes.

Much work has been done in this line with varying results. Berzelius obtained sodium and potassium sulphites by reduction of their sulphates in a current of hydrogen. Berthier obtained them by reduction with carbon. Many attempts have been made by Claus and others to make use of Berthier's method for the production of sodium sulphide, but unsuccessfully. In their work they obtained products which contained thiosulphates and carbonates due to oxidation by the air in their process of manufacture. This, however, can be avoided by using carbon in the form of bituminous coal where volatile matter is given off to keep the furnace full of a reducing atmosphere and carrying the reduction out in a design of furnace which can be kept air tight. It has always been considered this reaction required a high temperature, but in my work I have found that 96 per cent of the sodium sulphate can be obtained in the form of sulphide at a temperature not to exceed 650 deg. C., which can be easily maintained in a cast- or wrought-iron tube furnace.

At high temperatures the sulphide will attack the iron or even many kinds of brick, but at this low temperature it attacks the iron only slightly, forming in time a thin black scale of an iron sulphide when the reaction ceases. This, however, will scale off if the furnace is suddenly cooled or heated, but by gradually cooling or heating the furnace, the greater part of the scale will adhere and the tube last for months for this operation. In a rotary type of furnace the tube may also be made in sections and when one section wears out it can be easily replaced. It might be of interest to state that this scale mentioned above forms only at the hottest part of the furnace, which, as stated, never exceeds 650 deg. C., consequently this section would be the only one needing replacing.

The carbon added to the sulphide is in excess of that required for the reduction, and consequently the cinder will contain some unused carbon and require leaching and crystallizing to recover the sulphide in marketable form. It might also be stated that means must be provided for cooling the material as discharged from the furnace out of contact with the air.

Other products may be made from nitre cake, as sodium sulphide and the like, but it appears to me that the manufacture of the sulphide, owing to its increasing demand, would go a long way in disposing of what now is one of the largest waste products we have.

Nitrogen Fixation Furnaces*—I

A Review of the Various Types of Arc Furnaces, with Details of the Kilburn Scott 3-Phase Furnace—Balance of Current Phases, Size and Starting of Furnaces—Radiation and Cooling-Water Losses—Electrodes

BY E. KILBURN SCOTT

Arc furnaces for fixing atmospheric nitrogen differ from arc furnaces for making alloys, carbide, etc., in that instead of the electrodes being of carbon they are made of special metal which wears away very slowly. Also, the potential used is several thousand volts, which necessitates better insulation. Another difference is that air only is used or charged; the internal construction is therefore simpler as regards the refractory lining, for there is no melted metal or flux to react with or to cut the brickwork.

The furnaces are especially suited for intermittent working with off-peak power, because they can be started and stopped at any moment with almost the same facility as an ordinary arc lamp, and there is no fused material to be run off or to freeze in case the electricity fails; also, after starting up again, full yields are obtained very quickly. The furnaces may therefore be advantageously installed wherever cheap 3-phase power is available for say sixteen or twenty hours a day. The arc process is the only method for fixing atmospheric nitrogen that can be so used.

A convenient size of air nitrate factory is one to take about 10,000 kw., but of course the larger the factory the lower the cost per kilowatt of plant installed and the lower the working cost and of overhead charges per unit of finished product. The ordinary standard voltages of 5500 and 6600 and periodicities of 25 and 60 per second are suitable, so it is not necessary to install special generating machinery. The energy can be tapped from a general transmission network, although there are advantages in having the factory near to the power house.

To combine nitrogen and oxygen efficiently by electricity it is necessary to obtain as intimate contact as possible between the gases and the arcs, and various features which more closely approximate to this requirement are discussed in this paper; further, in order to emphasize certain points, comparisons are made of types of furnaces, especially those which produce the arcs in different ways. For the purpose of discussing types of furnaces, they can be classified as follows:

(A) Designs having mechanically movable parts.

(B) Designs employing a magnetic field to direct the arcs.

(C) Designs depending on air currents only to direct the arc.

Designs Having Mechanically Movable Parts

The Bradley and Lovejoy apparatus as it was installed at Niagara Falls is historical but nevertheless interesting, because it is a distinctive type. It depended on the formation, prolongation and interruption of many thousands of sparks or arcs per second, each one separate from the rest. The arcs were produced by rotating an iron cylinder fitted with platinum points inside a fixed enclosing cylinder having an equal number of points. Direct current at 10,000 volts was employed, partly because the apparatus was built at a time when that form of current was generally in use. It was afterward appreciated that it would have been better to work with alternating current.

MacDougall and Howles, who were working on the problem in England about the same time, employed alternating current, and the writer gave them assistance, especially in showing how the arcs could be stabilized by reactance.

Another design depending on mechanical movement is that of J. S. Island of Toronto; see Fig. 1. There are in this furnace four V-shaped rings, two of which rotate, and the electric arc which would normally remain stationary at the shortest gap is drawn around. To the eye it looks like a ring of flame, but in reality it is a single arc rotating rapidly round the annulus. Air passes through perforations in the apices of the stationary rings, and at first sight this would appear to be a good plan. The writer's experience, however, is that such holes are subject to excessive burning.

The Rankin furnace, to which T. H. Norton draws attention in an article in the September, 1917, *Scientific American*, has been tried in California. It is a distinctive type because the arcs are mechanically caused to move through the air, instead of the air being blown through the arcs. The sparking points are fitted in a sort of piston which reciprocates in a cylinder and at the same time is rotated to and fro by a thread on the spindle. Current is led to the sparking points by wires through the hollow spindle.

As general comment on the above, the writer considers that designs depending on a number of electric sparks or arcs which are at relatively large intervals apart must necessarily allow considerable quantities of air to pass without contact. Further, designs which require constant mechanical movement of parts are obviously at a disadvantage when compared with those referred to below, which do not require moving parts.

Designs Employing a Magnetic Field

The Moscicki furnace, used in Switzerland, has a magnetic field which causes the arc to rotate around an annular opening. Referring to Fig. 2, there is a reaction chamber with an air chamber below, both of which are surrounded by water. The annular opening is formed between a high tension electrode and the lower edge of the reaction chamber, which latter is

*A paper presented at the thirty-fourth general meeting of the American Electrochemical Society, held at Atlantic City, N. J., Sept. 30, 1918.

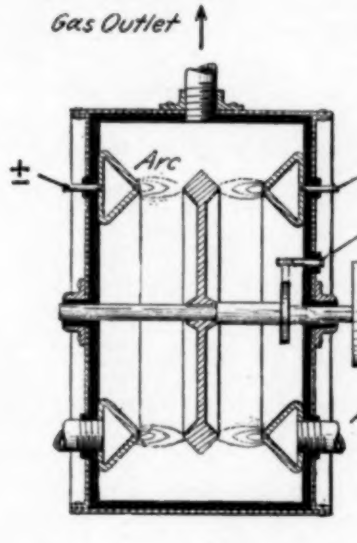


FIG. 1

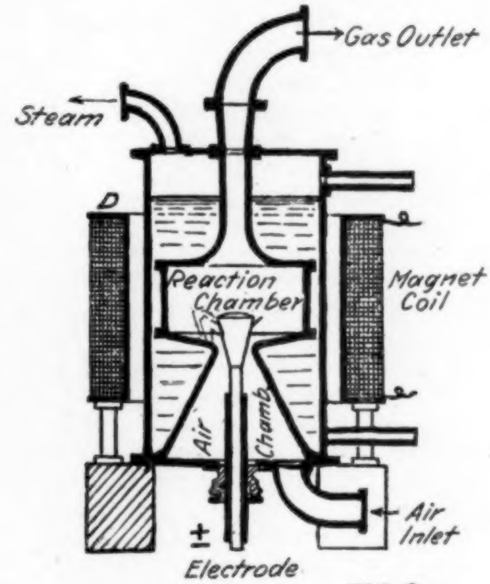


FIG. 2

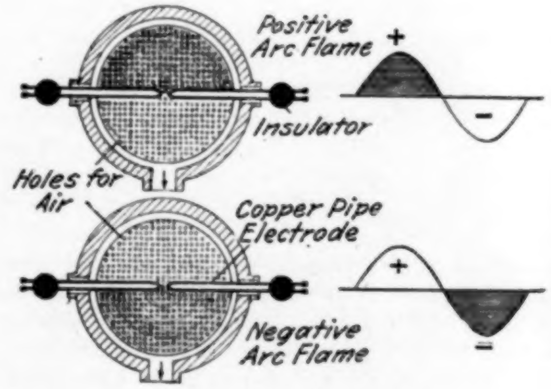


FIG. 3

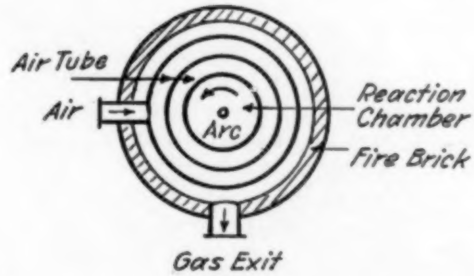


FIG. 4

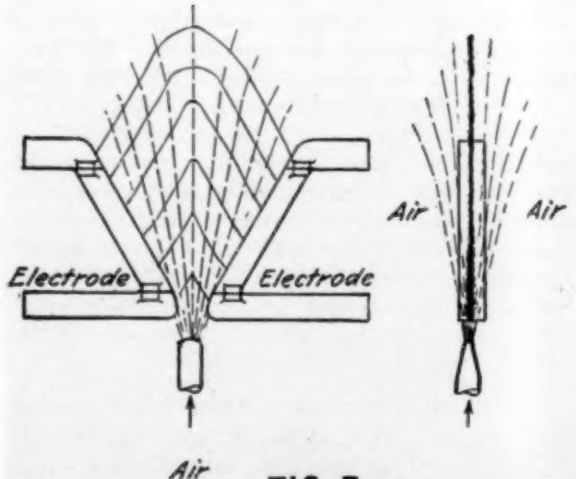


FIG. 5

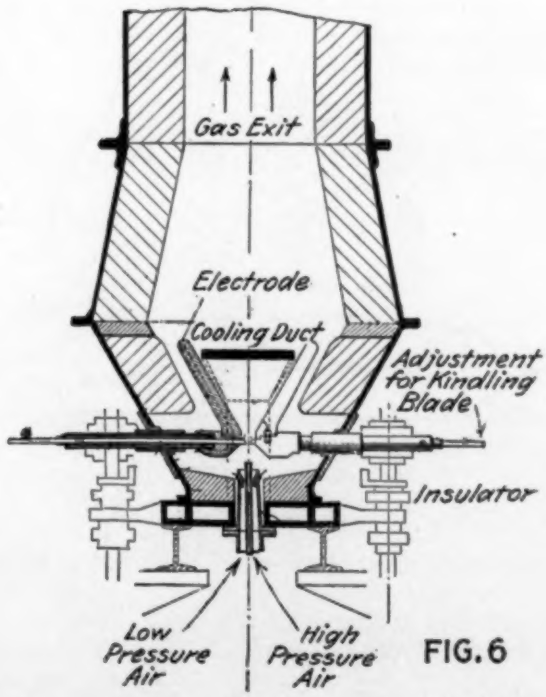


FIG. 6

FIGS. 1 TO 8

Fig. 1—The Island furnace, with mechanically rotated arc. Fig. 2—Moscicki single-phase furnace, having magnet coil to give rotation of arc. Fig. 3—Alternating arc flame of Birkeland-Eyde furnace. Fig. 4—Cross-section of reaction chamber and annular preheater tubes of Schoenherr furnace. Fig. 5—Arc flow in relation to the arc of a Pauling furnace. Fig. 6—Modification of Pauling design due to Phaehler and Heckenbleckner.

earthed. Magnet coil D, acting in conjunction with the steel construction of the furnace, sets up a magnetic field across the annular opening which causes the arc to rotate. It can, however, only be at one point at any one moment, whereas air passes through the whole opening all the time; it therefore follows that a large proportion cannot contact with the revolving arc.

The Birkeland-Eyde furnace, used in Norway, France and Spain, has also a magnetic field, but in this case it forces the arc into two half discs of flame, which alternately rise and break in the top half and in the bottom half of the reaction chamber. The electrodes, see Fig. 3, are of copper tubes supported on ball insulators, and they project into a circular reaction chamber, the side walls of which are pierced by a large number of small holes. Air passing through these holes strikes into the flame at right angles, and obviously at any moment only half the volume can enter on the side on which is the arc.

The arc constantly rises and breaks, and, further, many of the holes are near to the edge of the reaction chamber. A large proportion of the air, therefore, fails to make contact with the arcs. As further general comment on those furnaces which depend on a magnetic field to direct the arc, the writer is of opinion that they are at a disadvantage compared with those mentioned below, which use air only, because of the expensive magnet steel construction which interferes with accessibility, the cost of copper magnet coils and the cost of dynamo electric machinery necessary to provide direct current to excite the coils. Another reason is that an extra circuit is required, with instruments and regulating switches, etc., in order to adjust the strength of the magnetic field to suit the velocity of the air.

Designs Depending on Air Currents

In the Schoenherr furnace, as used in Norway, air is blown tangentially into the bottom of a vertical reaction tube made of steel, and in passing upward with

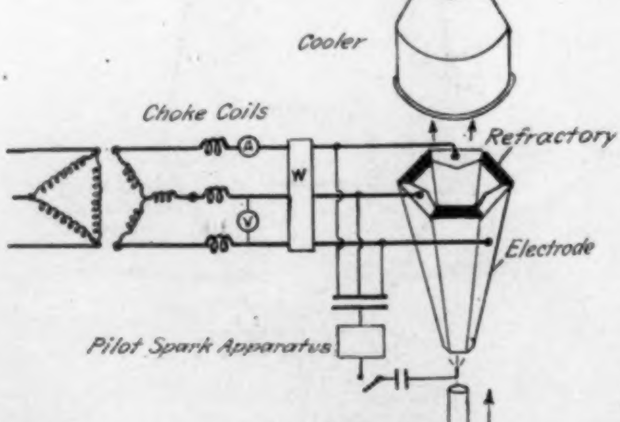


FIG. 7—DIAGRAM OF KILBURN SCOTT 3-PHASE FURNACE

a whirling motion it maintains a rod-like arc in the center. To distinguish this arc from those of other furnaces, the writer calls it a "standing arc." The cross section of the reaction tube, see Fig. 4, is about 30 sq.in. (190 sq.cm.), whereas the section of the arc is only a small fraction of an inch; therefore much of the air whirls past without coming into intimate contact with the standing arc. A point of interest in this design is that it has a special air preheater combined with it. This takes the form of annular tubes, as shown in Fig. 4, through which the hot gases and the air pass in contra-flow directions.

The Wielgolski furnace, used by the American Nitrogen Products Co. of Seattle, Wash., has also a standing arc, but instead of being similar to a single straight rod it is in the form of a "bight" having its ends springing from electrodes at the bottom. For a given voltage, the height of the arc is therefore considerably less than in a Schoenherr furnace. Each electrode is a water pipe bent into a ring and air passes up through it.

The Pauling furnace, used in Italy, Austria and Germany, has a fan-shaped arc flame which forms between horn-shaped castings. Below the electrodes

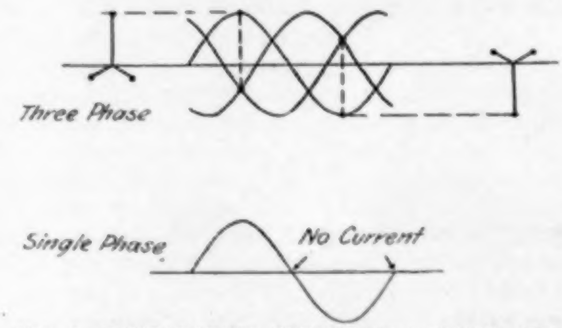


FIG. 8—COMPARATIVE CURVES OF 3-PHASE AND SINGLE-PHASE

there is an air pipe having a narrow slot, the idea being to get as much air as possible into the flame, but as a matter of fact it spreads out in all directions, as indicated in Fig. 5. Fig. 6 shows a modification installed at Nitrolee, S. C., and due to R. Phaehler and I. Heckenbleckner. Each electrode is supported at the bottom only, and the cooling water enters and leaves at that point, experience having shown that an upper connection causes short circuits and is difficult to insulate. Air is blown through two nozzles, the inner one passing a relatively small quantity at high pressure so as to cool the kindling blades. The bulk of the air, which is preheated, passes through the outer nozzle at low pressure. The power is therefore less than would be the case if all the air were at high pressure. Each side wall between the electrodes and just above the zone of maximum heating has a duct through which gases from the furnace, which have been cooled down, are blown. The object is to cool the highly heated nitric oxide below the critical temperature of dissociation, and as the return gases contain practically the same percentage of nitric oxide gas as the freshly treated gas there is no dilution.

The Kilburn Scott Furnace

Furnaces which work with single-phase alternating current have to be used in sets of three on a 3-phase supply, whereas the Kilburn Scott type now to be described in greater detail uses all three phases in a single reaction chamber.

As shown diagrammatically in Fig. 7, it has three wedge-shaped electrodes arranged with intervening re-

fractory material so as to enclose a 6-sided conical space, having its apex at the bottom. Three-phase current supplied to the electrodes produces a combined arc which is flared out by the air, and with 60 periods gives 360 flames per second.

By drawing three sine curves with a phase displacement of 120 degrees, as in Fig. 8, it is seen that current is always flowing in the reaction chamber, and it can be shown mathematically that the electric energy varies between 0.86 and 1.0. On the other hand, with the single phase the energy varies from zero to maximum, and twice in each cycle there is no current.

The flame appears to the eye like a double cone having one apex at the bottom, where the electrodes are nearest together, and the other at the top, where the flame tapers off. The flames flicker about with great rapidity in different planes, and so are constantly intercepting fresh particles of air. Fig. 9 indicates how it

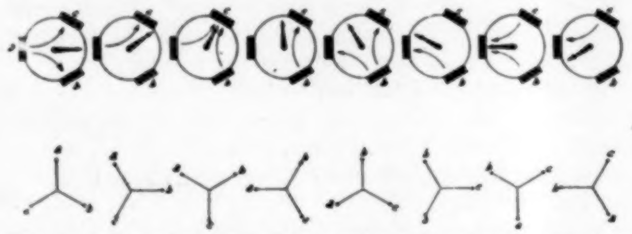


FIG. 9—DIAGRAM SHOWING ROTATION OF 3-PHASE ARC

revolves, the speed of revolution corresponding to the frequency. If we assume 60 periods per second, then as it takes longer than one-sixtieth of a second for air to pass up the reaction chamber, it follows that practically every particle must come into the arc field.

From the point of view of the supply of electric energy, it is desirable to have all three phases balanced, and this is especially necessary when current is purchased from a public supply company, for the general supply must not be affected by low power factor and unbalanced and variable loads.

When single-phase furnaces are connected to a 3-phase supply, there may be considerable lack of balance due to one furnace dropping out of circuit; also at starting up, unless all the furnaces are switched in together. If one arc fails, there is a possibility that the circuit breakers of the other furnaces may trip, with the result that a heavy load is suddenly thrown off and a surge may set up.

The 3-phase furnace gives no trouble in this way, for it functions as a single unit and the phases balance automatically. Even if deliberately set so that they do not balance, they tend to equalize by burning at those points where current is greatest. There is very little chance of a 3-phase furnace failing altogether, because the three phases help to maintain one another.

Starting Up the Furnace

As the electrodes of nitrogen fixation furnaces are of metal and work at high voltage, they must not be brought into contact. Starting is usually effected by carefully moving the electrodes until they are near enough for current to jump across. After running until the interior has become heated, the electrodes are withdrawn to the regular working distance. Adjustment must be made carefully to minimize rush of current, and as this depends on the furnace attendant, the amount of reactance in circuit has to be sufficient to allow for the contingency of careless operation.

The Schoenherr furnace is started by means of a lever which is moved by hand until it is near enough to the lower electrode for the current to jump across. The lever is then withdrawn and the whirling air carries the arc to the top of the reaction tube. If the arc fails, which is fairly frequent, it has to be rekindled by hand, so considerable attention is necessary.

Pauling uses the device shown in Fig. 10, which shows two furnaces connected in series in each leg of the 3-phase supply and an auxiliary transformer connected across one pair of electrodes on each series. The high tension coil of this transformer gives a voltage several times greater than the main supply, and the arcs are kept going by the higher voltage set up by current shunted through the primary coil.

While experimenting with an early model of the Kilburn Scott (K. S.) 3-phase furnace, it was found possible to use pilot or trigger sparks to break down the air dielectric and thus dispense with movement of the electrodes for starting. This is a simple solution of the problem and does away with uncertainty of operation by an attendant. A wire placed midway between the three electrodes just above the central air nozzle is connected to an extra high tension supply, which causes sparks to jump from the wire to the electrodes, thus ionizing the air and causing the main current to flow. The more pilot sparks there are in a given time the better the effect; also, the higher the frequency the less the air resistance. The two circuits work together in much the same way as when telephone and telegraph messages are carried at the same moment through one set of conductors.

With pilot sparks to break down the air dielectric between the three electrodes, the full value of the current wave is utilized and the curve approximates

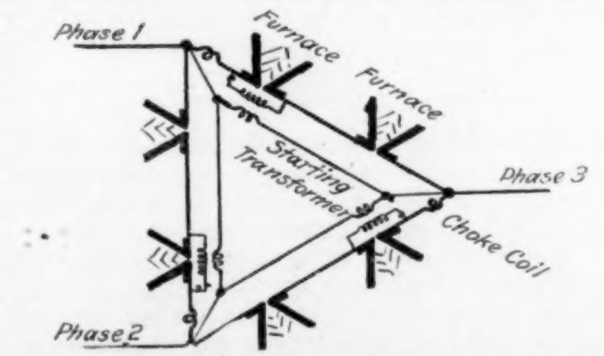


FIG. 10—PAULING FURNACES IN SERIES ON EACH PHASE AND STARTING TRANSFORMERS

to a sine wave. On the other hand, with single phase the voltage has to rise to a certain amount to overcome resistance and cause current to flow.

Size of Furnace

A 3-phase furnace is better than three single-phase furnaces aggregating the same power, because there is only one piece of apparatus to attend to and the cost is at least halved; also the space occupied, inclusive of passage way around the furnaces, is less.

As a 3-phase arc flame increases in three dimensions with increase of power, it follows that kilowatt capacity goes up very rapidly with increase of size. Usually

in mechanical designs doubling the linear dimensions will theoretically increase the capacity eight times, but a 3-phase furnace for nitrogen fixation increases in much greater ratio.

Speaking generally, the larger a furnace the more accessible are the interior parts and the easier it is to adjust and renew the electrodes. Radiation losses are also relatively smaller, and the percentage of energy absorbed by the reactance coils being less, the power factor tends to be higher.

The Schoenherr design is limited to about 1000 kw., because the length of the reaction tube is governed by the voltage, while at the same time the current that can be dealt with from a single electrode is limited.

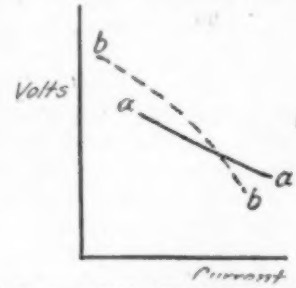


FIG. 11—CHARACTERISTICS OF ARC AND ALTERNATOR

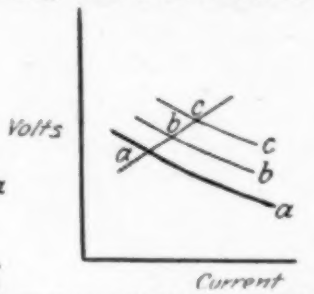


FIG. 12—FALLING AND RISING CHARACTERISTICS OF ELECTRIC ARCS

Again, the amount of air that can be passed through a reaction tube at a given velocity is limited, so in order to increase output a larger diameter tube would have to be used, thus giving greater clearance around the arc.

Birkeland-Eyde furnaces are now built with a capacity of 4000 kw., which is about 20 times larger than those made some twelve years ago. They are essentially a single-phase design. During the same period, carbon-arc furnaces for making alloys and for carbide have increased in a much greater ratio, and they are all now made for multi-phase working.

Radiation and Cooling-Water Losses

In the Schoenherr furnace, radiation accounts for 17 per cent and the electrode cooling-water for about 30 per cent. It is therefore desirable to design electric furnaces with as small radiation surface as possible and with a minimum of electrodes through which heat can pass to the outside air.

Radiation loss varies directly as the wall area of the furnace, and cooling-water loss may be said to vary with the number and the size of the electrodes. Two electrodes being the least that can be used for any one furnace, it follows that three single-phase furnaces must have six electrodes while a 3-phase furnace of the same total power has only three.

Three electric arc flames acting together in one closed space will give a higher average temperature than the same arcs each at some distance apart and within separate walls each radiating heat. That is to say, a 3-phase furnace of 3000 kw. will have less wall area and therefore less radiation than three 1000-kw. single-phase furnaces; also the heat absorbed in cooling three electrodes of one furnace will be less than for cooling six electrodes of three separate single-phase furnaces.

Doubling the number of electrodes means doubling the pipe connections and fittings, also electric cables, etc.; and as the water connections must necessarily be connected to the high tension supply, it is an advantage on this account to have as few as possible.

In furnaces with diverging electrodes, heat is principally generated about one-third the way from the bottom, so the cold water should impinge at about that point in order to keep the metal from being worn too rapidly. At the same time, in order not to reduce the temperature of the reaction chamber too much, it is necessary to adjust carefully the amount of cooling water.

Electrodes

The writer's conception of a blown-arc flame is that it consists of arc threads or streamers, which strike across the bottom of the electrodes and then, acting like flexible conductors, are carried up by the air current. The ends move rapidly over the surface of the electrodes until the arcs have reached the maximum length at which the voltage will sustain them, when they snap suddenly and new arcs are started.

If the formations and extinctions of the arc threads synchronize exactly with the alternations of the electric current, then the furnace is working smoothly, and it is easy for those accustomed to such furnaces to know this by the sound.

Around each arc thread there is a flame of burning nitrogen, and as nitric oxid forms it diffuses away into surrounding air and in so doing becomes cooled. Probably the quickest chilling takes place at the moment when each arc-thread breaks. The arc also tears particles of metal from the electrodes, and these, becoming

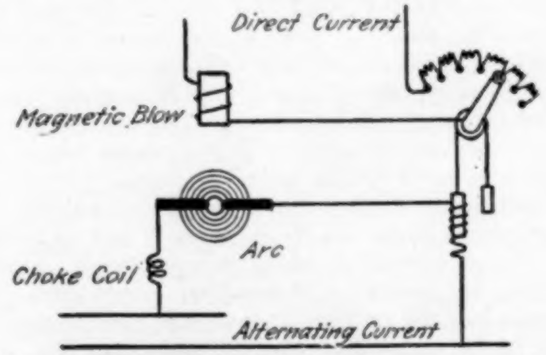


FIG. 13—DEVICE FOR STABILIZING THE ARCS OF BIRKELAND-EYDE FURNACE

incandescent and oxidized, may play some part in expediting or retarding the reaction, for it is known that some metals are better than others from the point of view of yield of nitric oxid.

With diverging electrodes, the ends of the arcs travel along the surfaces in leaps, which is possibly due to softening of the metal, and the arc is momentarily held at each point until pressure of air (or the magnetism in the Birkeland-Eyde furnace) overcomes the adhesive tendency. When the surfaces of electrodes are large, the wear is relatively slow and the electrodes need renewal only at long intervals. On the other hand, when the arcs spring from the end of an electrode, as in a Schoenherr furnace, burning is intensive and the electrode has to be fed forward regularly.

The electrodes must be of dense metal having high melting point and not readily oxidized; also it should be a good heat conductor so as to pass heat quickly to

the cooling water. Steel is used in the Schoenherr and Moscicki furnaces, but it is not a good metal because the magnetic oxide of iron to which it burns may be carried over to the absorption towers and stain the acid. Steel begins to oxidize at about 370 deg. C., and oxidizes rapidly at about 500 deg. C. Nickel has an ignition temperature of about 650 deg. C., but it is too expensive to use, and this remark also applies to many metals and materials which have high melting points—platinum, for instance. Those working on the nitrogen fixation problem are always on the lookout for better electrodes.

In this connection, the process called "calorizing" is of interest, because it raises the oxidizing temperature. The process depends on the fact that at high temperature and in a neutral atmosphere powdered aluminium will enter into combination with a metal and form a homogeneous alloy which cannot be destroyed except as part of the mass of which it is part. Depth of the impregnation depends on the length of time of treatment, and by it the oxidizing temperature of steel can be raised to over 1000 deg. C.

Copper is a good metal to use for electrodes, because it is easily made to the required shape and wears away smoothly without releasing troublesome vapors. After a run with some copper electrodes which were fixed by steel screws, having their countersunk heads in line with the path of the flame, it was noted that the steel was considerably burnt, whereas the surrounding copper had only slight surface marks.

It is important to minimize the oxidation, because when a considerable amount of electric energy is employed in vaporizing metal, then there is so much less energy for exciting the gas molecules and bringing about the nitric oxide reaction.

Birkeland-Eyde furnaces use tubes of pure electrolytic copper about 2 in. (5 cm.) in diameter and $\frac{3}{16}$ in. (5 mm.) thick, bent into the form of a U, each leg of which is about 8 ft. (2.4 m.) long.

Electrodes of copper alloyed with other metals have been used to advantage, and those metals which show good nitrogen bands in the arc spectrum are obviously the better ones to employ.

There is some reason to suppose that the presence of metals or oxides of metals act in a catalytic way in increasing the velocity of the reaction. The action of a catalyst is supposed to be such as to make it unnecessary to use higher temperature to get a workable velocity.

For smooth electrical operation it is important to have the arc stabilized, and this is the condition which gives good yields of nitric oxid. Further, it is important to have the furnace working easily, because of the effect of an unstabilized arc on the supply circuit. An ordinary arc lamp works well, because the carbons are automatically moved so that the distance between them increases with current, to effect which an electro-mechanical device is used. This is possible because the parts to be moved are small and of light weight, but obviously the heavy metal electrodes of large electric furnaces and the large power involved present a much more difficult problem.

The resistance of an alternating arc varies with current in such a way that when the voltage between the electrode decreases the current then increases. In other words, the characteristic of the arc is a falling one, as shown by curve *aa* of Fig. 11. If the voltage of supply can be made to fall in accordance with the arc characteristic, then complete stability of the arc is obtained, but to do this the only way is to specially design the alternator for a large voltage drop, as shown by curve *bb*. The writer has used such an alternator with good effect, and it is of interest to note that the latest installation in Norway, at Rjukan II, has alternators with large voltage drop, each supplying a group of three single-phase furnaces of 4000 kw.

When an air nitrate factory receives energy from a transmission line so that step-down transformers are required to reduce the voltage to that required by the furnaces, then reactance may be embodied in the transformer. The transmission line itself and the various connections, etc., also give some reactance, which goes toward reducing that necessary in the separate reactor.

It is obviously desirable to design a furnace so as to work with as little reactance as possible, and one way is so to design the electrodes that they require little or no adjustment, for obviously reactance must be larger if the contingency of inexpert adjustment has to be met.

Stabilizing an arc against what may be called abnormal conditions may be done by automatically varying the force of the air in accordance with current in the arc, for increased air pressure increases the arc voltage. With varying air pressures the arc characteristic will move out parallel to itself, as shown in curves *bb* and *cc* of Fig. 12. An automatic device may be employed to do this, so giving the equivalent of a rising characteristic, as shown by the curve *a*, *b* and *c*.

F. G. Lilienroth has suggested such a device, and for a Birkeland-Eyde furnace (see Fig. 13) he provides a regulating switch in the field-magnet circuit, which switch is varied by a solenoid through which passes the current of the electrodes.

(To be concluded)

Restoration of Belgium

At a recent meeting of the New York Section of the Society of Chemical Industry a resolution, introduced by Dr. Jerome Alexander, was passed which, after reciting that Germany had deliberately stolen, destroyed or carried away machinery and property in occupied territory and had deported or destroyed communities of skilled artisans, all for the purpose of permanent economic injury of competitors in the world markets, read as follows:

Be It Resolved, That the New York Section of the Society of Chemical Industry requests that the proper authorities of the various allied Governments take special note of the above facts and insist that Germany, where possible, be compelled to restore the stolen machinery and other property, or replace the stolen property and also whatever machinery or property has been destroyed, by equivalent machinery or property taken from German factories; and that they furthermore see to it that all allied industries are fairly and justly safeguarded under the ultimate terms of peace against the machinations of an insidious and conscienceless enemy, whose express intention is to reduce other nations to industrial subservience and dependence.

Future of Pure and Applied Chemistry*

Account of the Political Aspects of Chemical Science in the British Empire — Retrospect on Conditions Prevailing at the Start of the War and the Sudden Changes That Were Brought About Thereby

BY WILLIAM JACKSON POPE

FOR THREE years pure chemical research has been dormant the whole world over, and it would be difficult for the most accomplished essayist to arrest attention for an hour by an address on a subject of purely academic interest. Our mental point of view and our outlook upon both present and future are entirely different from those of four years ago; although the present is obscure and painful, the future gives promise of brilliant and rapid developments in natural science in general and in chemistry in particular. In this belief I venture to lay before you some reflections upon the growing recognition of the importance of our science and upon the responsibilities with which, owing to this change in public opinion, our shoulders are laden.

I have often heard the statement made by men who have grown old in the service of science that chemistry, and particularly applied organic chemistry, is a subject in which the British nation can never excel; that minute attention to detail, coupled with the power of organization and coöperation, entails something antipathetic to the British character; the Germans, we know, have often expressed this view. The events of the last three years have sufficed to dissipate this fallacy forever. The manner in which Great Britain, caught in the autumn of 1914 with scarcely any resources in the shape of equipment for the manufacture of fine organic chemicals, has rapidly become a larger producer of explosives, pharmaceutical, photographic and other essential chemicals than Germany will remain an enigma to the historian of these present times. The obscurity which surrounds this rapidly executed operation is not diminished by the existence of difficulties which have naturally acted as inhibiting agents.

This country enjoys in a greater measure than other states a representative government, and, in spite of the many advantages of such a form of government, the fact remains that it necessarily admits of no representation of any phase of public opinion not loudly and insistently expressed. Science has always been in this latter position; it has been unvocative. During the first few years of the nineteenth century, Dalton enunciated the atomic theory, Thomas Young stated the undulatory theory of light and James Watt invented the steam engine, and by these events all the amenities of human life have been revolutionized; indeed, they have exercised vastly more influence on the well-being of our race than did the Napoleonic wars. So accustomed are we, however, to routine habits of thought that most of us would probably answer, in reply to a suddenly posed question, that the battle of Trafalgar was the most pregnant event of the first quarter of the nineteenth century.

THE POLITICAL POSITION OF CHEMISTRY

A brief moment of reflection would lead us to correct this hasty statement. Sodium was discovered by Davy in 1807, and benzene by Faraday in 1823. From sodium we obtain sodamide, the prime agent in making artificial indigo an economic possibility; the separation of benzene from coal-tar led by logical sequence to the production of Perkin's mauve and of thousands of other synthetic coloring matters, and to the manufacture from coal-tar anthracene of synthetic alizarin, the first heavy blow aimed at the position of the Turkish Empire, involving as it did the ruin of the Turkey-red or madder industry. The first practical process for making aluminium depended on the use of Davy's sodium, and with the aid of Davy's safety-lamp 250,000,000 tons of coal are mined annually in this country with comparatively slight risk. Faraday's early investigations on the chemical aspects of electrolysis and his studies on magnetic induction led immediately to the invention of the dynamo, and, through Clerk Maxwell, to the introduction of wireless telegraphy; this one branch of Faraday's investigations, in point of fact, constitutes the ground-work of the whole stupendous vista of results of the general introduction of the electric current into modern life which is so familiar to us all. Cavendish's early production of nitric acid by the passage of an electric spark through air, reproduced on an enormously larger scale, is now furnishing Central Europe with the nitric acid without which no explosives could be manufactured.

Any one who is in the habit of reading modern historical writers—and they have become quite illuminating since a scientific mode of writing history has been substituted for the older fictional style—knows how political changes, national reforms arising from an effort of the collective conscience, the magnetic influence of some popular demagogue, and the like, are invariably invoked as explanatory of all the vicissitudes of our planet.

The modern historian is here taking a false point of view, and since he is, in general, quite unacquainted with physical science, his methods are inadequate. The whole history of Europe for the last century has been made within a few hundred yards of Burlington House in our scientific laboratories. One of the most potent incentives to political changes resides in the desire to increase the amenities of life, and research in pure science has had for a hundred years past the greatest influence in facilitating the realization of that desire.

*Abstract of the presidential address delivered at the Annual General Meeting of the Chemical Society, March 21, 1918, in London.

Coöperative effort, one of the most striking aspects of modern life, only became possible when science provided the facilities for municipal power schemes, for telegraphic connection over the whole world, and for the concentration of production in definite centers. Chemical science is still furnishing the means for further revolutionary changes; during the last few years we have seen great technical developments of purely scientific discoveries—the work of Dewar on the liquefaction of gases, and that of Cross and Bevan on viscose and artificial silk, both of which have led to the profitable utilization of vast amounts of capital—and it is as yet impossible to indicate the ameliorations of the conditions of human life which will inevitably result from contemporary chemical investigation.

In a time of crisis like the present, British custom tends toward the replacement of unreal conventions by what is really vital; we have been engaged upon this operation for several years. While previously unheard-of changes have succeeded each other kaleidoscopically in the national constitution, in the political parties in power, in the freedom of the subject and in hosts of other ways, the nation has recognized that science is the only real maker of history. The whole empire is now one vast chemical and engineering laboratory, and we even live on a scientific ration of so many calorific units. It is obvious that chemistry, with physics, engineering, preventive medicine and others of the natural sciences, which previously had no imperialistic position, because powerless to make or break a Government, have become the pivot on which turn all our hopes of retaining an independent national existence; it has been suddenly realized that supremacy in these branches of knowledge is vital to our country.

The Position of Scientists in the State

The time is approaching when this state of affairs will change; neglect of the natural sciences will then no longer put us in danger of sudden extinction, but, as was taking place years ago, will lead to our slow, certain downfall as a nation. The responsibility is placed upon our scientific men of taking such measures as will insure that the old order is not re-established, that science makes her voice heard in our national councils and that policies of drift are forever abandoned.

We have in this country three large and long-established organizations devoted to various phases of chemical science: the Chemical Society, the Society of Chemical Industry and the Institute of Chemistry. It is too much to ask that these three representative bodies, with perhaps the newly-founded Association of British Chemical Manufacturers and ultimately all the other cognate but more specialized interests, should set up a watchful and alert joint council with directions to consider national questions in which any of the varied interests of chemistry are concerned and to make such representations to our administrators as would voice the corporate view of the joint body.

I am inclined to think that, had such a body been in existence several years ago, much that has been accomplished in the interval by somewhat devious methods would have been better done. One instance will occur to every one: that of the much-debated question of the re-establishment of the coal-tar color industry in Great Britain. The scheme adopted by the Government for resuscitating this phœnix in our country, after its past thirty years of profligate productivity on the Continent, was launched without scientific advice; the Cabinet mouthpiece, indeed, declared that the directorate of the company was not to include men of scientific knowledge, on the ground that a director who knew something about the business of the company would have an advantage over his less well-informed colleagues.

Owing largely to the fact that we possess no strong collective council, representing the combined academic, scientific and industrial aspects of our science and capable of representing them before a representative Government, it may be argued that we chemists are not altogether blameless for the particularly blundering way in which particular errors have been perpetuated by the responsible officials. While we should be thankful that our blunders have not led to our destruction, we should proceed without further delay so to organize the resources of chemistry as to make it possible to enforce the adoption of scientific methods and modes of thought by authorities to whom these are yet strange.

The serious character of the British position in connection with the coal-tar color industry becomes more evident when one considers that this is a key industry; upon it depend the textile, paper, photographic and pharmaceutical industries. The total capital employed in the organic dye industry in Great Britain is between four and five million pounds, while the capitalization of the German coal-tar color firms is of the order of fifty million pounds. The need for greater and more intelligent activity in this direction is obvious; unless national enterprise can be stimulated into providing adequately for the manifold requirements of Great Britain and her colonies in all those industries which depend on coal-tar color manufacture, we shall be again in the hands of the foreign producer.

The control of a national dye scheme by business men with no real feeling for the enterprise on which they are engaged renders it fairly certain that the wider aspects of coal-tar color manufacture will be neglected. The interweaving of the color interests with those of synthetic pharmaceutical, photographic and other chemical industries is essential to success. The utilization and development of the resources of the empire in natural coloring matters such as indigo is necessary from a national point of view. The careful study of our own and other codes of patent law in their bearings upon the fine chemical industry is also important. These weighty questions cannot receive adequate consideration from any purely lay body. It is mournful but instructive to compare our present position in the coal-tar industry with the prospects which that branch of applied chemistry exhibited to Great Britain in early days. The first coal-tar color was made by Perkin in 1856, and in 1862 Prof. A. W. von Hofmann, one of the foremost chemists of the day, a German, domiciled in this country, painted an alluring picture of the future in store for us. Said he: "England will, beyond question, at no distant day become herself the greatest color-producing country in the world, nay, by the strangest of revolutions, she may ere long send her coal-derived blues to indigo-growing India, her tar-distilled crimsons to coch-

ineal-producing Mexico, etc." When we contrast this dazzling prospect, made by one of the most far-sighted of contemporary German chemists, with the actual situation, we cannot but ask why the event fell so miserably behind the forecast.

The Modern Education

The reason, in my opinion, lies in the fact that opulent, indolent Great Britain has for the past century permitted all its educational interests to pass into the hands of a particular caste which despises all knowledge difficult to attain, and, to camouflage its own idleness, has always pressed the notion that a first-hand knowledge of the facts of natural science and the conclusions to be drawn therefrom is unimportant, and that the young man or young woman does his or her best in the world if thrown into it entirely destitute of anything but an evanescent acquaintance with certain classics and a decided taste for so-called learned leisure. The greater among the ancients were creators of new knowledge as well as masters of the whole accumulated world's stock of information; their successors, unproductive of positive knowledge and very ignorant of the great changes taking place around them, can but wonder at and comment vaguely on the genius of Archimedes and Aristotle, and necessarily despise the achievements of Newton and Kelvin, their modern prototypes. Illustrations of the stultifying effect of a purely classical education are laid before us every day; one recent example may be quoted here. The gentleman who shares with Mr. A. J. Balfour the honor of representing in Parliament the greatest center of business and financial activity in the world made the following statement in the House of Commons recently while opposing Mr. Fisher's Education Bill: "It was said that education was necessary to make the rising generation good business men. His experience in the City was that the man who took Firsts at Oxford generally came out last, and that the man who could hardly write his name generally came out first. The explanation was that education could not put into a man that instinct of self-preservation and common sense which was the foundation of all success in business. How could education assist a farm laborer to spread manure on a field? The best laborer he had known was wholly illiterate. If the waste of the war was to be replaced, it would be necessary for the young to start as early as possible in doing a day's work, instead of wasting time on useless book learning." This representative of the City of London is a baronet of recent creation and a director of one of the largest London banks and one of the most important English railroads; he received his "education" at one of the oldest and most rigidly classical of our great public schools. Comment is probably unnecessary.

Every scientific man in the world realizes that an innate appreciation for fine literature, for great thoughts nobly expressed and for the appropriate delineation of our greatest aspirations are among the most sublime instincts of humanity and demand the most careful cultivation. Our literary men say that we cannot express ourselves effectively, and offer as a satisfying feast the old bones left us by the Greeks and Latins, chewed over for centuries until so devoid of nutriment that they led ultimately to the mental atrophy which characterized the Middle Ages, an atrophy that was only shaken off by the taste for knowledge which arose from the exploits of geographical science in the Elizabethan period.

If the power of expression rests with our literary friends, why are they so idle? It is their obvious duty to devote themselves to popularizing the natural knowledge acquired by the scientific observers of the past two centuries; this real learning has so infinitely extended human interest in the world around us and gives such promise of further conquests that an appeal for its consideration would certainly not have been made in vain to Plato or Lucretius. No one asks for the abolition of classical literary learning, but the whole world is now demanding that the young should be provided with an education which includes an insight into our present-day knowledge of the universe.

The rather petty disputes which rage about this matter of classical and scientific education are one-sided; the scientific man generally knows something of both aspects of the subject, while his classical compeer rarely has any acquaintance with science. Unfortunately, the great questions involved have more than a petty bearing upon the well-being of our nation. The classical school has held our country in such bondage that, to all practical intent, no person can be admitted to the higher public service unless he swear adhesion to the caste. It is almost regarded as a platitude that acquaintance with natural science disables a man from fulfilling any high public office; practically all the superior positions in the Civil and Diplomatic Services must be filled by men of classical instincts.

Trained Men for Government Staffs

I venture to think that the wisdom of this mode of selection has been seriously impugned during the last four years. The huge Government departments which have arisen of late may be divided roughly into two classes—those staffed by men of some scientific training and those staffed by classical university graduates. Any one who has had occasion to note the numerous recent criticisms on Government departments must have observed that these strictures have almost invariably been passed on administrative branches of the service; delay, the encumbrance of red-tape and inability to draw a decision seem indigenous in certain Government offices, and none of the numerous attempts at reform has been successful. The administrative services are those in which the classical man is predominant. Other branches, such as the home Army Medical Service, have practically never been charged with inefficiency; the worst that has been alleged is a suggestion of extravagance.

The department just named is staffed by men who have had at least the rudiments of a scientific education; if control in the Royal Army Medical Service had been vested in the classical scholar of ability but no knowledge, it is certain that the last three years would have seen a repetition of the Crimean campaign horrors and that the army mortality from disease would have been greater than that caused by the instruments of war.

Such a control, happily, has been avoided; it has been avoided merely because medicine possesses the collective organization for which I plead in chemistry, an organization so strong as to make the imposition of an irresponsible lay control unthinkable.

I have already directed attention to the frequently expressed opinion that, as a nation, we are incapable of excelling in the fine organic chemical industry; let me quote one instance, small in itself, but large in its consequences, in disproof of this view.

The ordinary photographic plate is sensitive only to a region in the blue of the spectrum, but by incorporating certain rather fugitive organic dyes with the sensitive film, the latter may be rendered sensitive to the green, yellow and red parts of the spectrum; photographic plates so treated are described as panchromatic. The quantities of the sensitizing dyes required for the whole world's consumption in normal times is minute, being, indeed, of the order of a few pounds per annum. Until 1915 these substances had never been made outside Central Europe, and little was known by us of their compositions or of the methods of preparing them, as they were all sold under trade names. The manufacture of these materials, small as was the whole business, had been industriously cultivated by the German color works, and, as these color sensitizers are essential in aerial photography, their scarcity became of serious import quite early in the war.

The experimental investigation of the whole subject was quickly put in hand in this country, and within a few months ample supplies of the usual sensitizers were produced. Further, the newly established Department of Scientific and Industrial Research financed the development of the study of photographic sensitizers; as a result of this action new sensitizing dyes have been produced which are far superior to the older ones. It is safe to assert that the manufacture of panchromatic plates has now attained a degree of perfection in this country such as will long defy competition.

This is but one case that may be quoted from among a host of others, all of which prove conclusively that, given a little encouragement and assistance, British chemistry is capable, not only of giving much needed relief in this time of strain, but of meeting every demand which can be made on it when the period of reconstruction commences.

While the absence of the powerful weapon provided by a collective chemical council, embracing all interests of the science, has made it impossible for us to render the most economical service to our country, it is perhaps satisfactory to reflect that hitherto all that has been sacrificed is economy. Our lack of power to enforce our views has led to financial extravagance on the part of the authorities; the lack of economy in time, which means lives, cannot be attributed to our chemists. The duty will fall to some future President at some later time to record the spontaneity with which the Fellows of this Society volunteered for service in our chemical works, our munition factories and with the Colors either in our gas service or elsewhere.

One aspect of this question, however, calls loudly for attention. For several years past our teaching staffs have been depleted, and but a small fraction of the normal number of young men have been able to present themselves for training in chemistry. While the present demand for capable young chemists is vastly in excess of the supply, an even more serious situation awaits us in the future. If hostilities were to cease tomorrow, five years would be needed before our colleges and universities could begin to supply the large numbers of young chemists which will be required for the development of the future great fine chemical industry of this country.

Surely this is a matter which should engage the serious attention of the country. If it prove necessary to import young chemists from neutral nations to man our reconstruction schemes, a handicap will be established which we may never outrun. The adoption of some scheme by which a sufficient number of juniors can be provided to help in the great developments which the future has in store for the scientific industries of the country is of the utmost importance.

The Value of Centralized Organization

It is impossible to reflect on the desirability of a closer coöperation between the large societies representing chemistry in Great Britain without foreseeing many directions in which such a union would be of value. As in every time of awakening, there exists at present a great feeling of unrest among the younger members of our profession; of late quite a number of propositions for the formation of new scientific societies have been promulgated, and all for the purpose of placing more power in younger hands and for insuring to the juniors more security of advancement. The final objects of these propositions, so far as I have understood them, are entirely praiseworthy, but it is to be feared that the methods suggested for their attainment are not always such as appeal to older and more experienced people as likely to prove successful. If we chemists collectively were in possession of some more centralized organization, such a one, for example, as is represented by the Chemists' Club in New York, with facilities for hospitality, meetings, library, laboratory accommodation and the like, no question could ever arise of the creation of a new chemical body unconnected with the main organization. A new and vigorous issue of the parent organization would shoot at appropriate intervals, and would remain contributing to the strength of the family under the original patriarchal roof. We greatly need a central home of all the chemical interests in the country, and premises, several times as large as the Chemical Society rooms, to use as a club, of which every chemist in the country would be a member. The question of the necessary expansion of the library, which is occupying the earnest attention of your Council, would find an easy solution in such a pooling of interests.

Notwithstanding that during the past forty years much has been done to facilitate the entrance of talented and promising young men into the scientific professions, far more progress must be made in this direction if we are to regain for Great Britain the paramount position she once held in scientific discovery. The Natural Science Departments in every university in the country call for expansion in personnel, laboratory space and equipment, and in provision for post-graduate research work; while scholarships for students in training are fairly plentiful, the difficulties which face the advanced student who needs to spend and who would benefit immensely by spending several years on original research are often insurmountable. Every professor of chemistry in the country can recall many instances in which he has had to send his students into technical life at too early a period, simply because it

has been impossible to secure for a good man the £150 to £200 per annum necessary for living expenses; the provision of this small sum would, in many cases, convert a half-trained chemist into a far greater asset to the state.

While a collective effort, exerted by all the interested branches of our science, to insure the efficiency of the newly-established organizations for furnishing the requisite relief is urgently desirable, it should be noted that it will become increasingly difficult to retain students capable of taking leading positions for a sufficient time to insure their proper training. During several years past I have been visited by gentlemen representing large chemical industries who have walked around my research laboratories to sort out the workers and to make overtures to such as they judged suitable for their own work; the pressure thus exerted upon the universities to force the premature delivery to the work of the best men they have in training will necessarily increase with the coming still greater demand for technical chemists.

Greater Remuneration Needed

The intellectual professions may be roughly classified in two categories: the productive and the parasitic. Those of the productive class, which include all scientific workers who produce new knowledge, are, in general, poorly remunerated; their practitioners are ordinarily so intensely held by the interest of the work in hand that they have little inclination to divert their energies to the necessary extraction of higher emoluments. The parastic class, on the other hand, have always been able to command ample remuneration for their labors; the reasons for this difference are various, and need not now be detailed. It may be noted, however, that at the jubilee of this Society in 1891 the veteran, Sir W. R. Grove, who in his young days did so much to develop chemical science, told us that he was led very reluctantly to desert chemistry for the law because "the necessities of a then large family gradually forced me to follow a more lucrative pursuit." The autobiography of the late Lord Playfair tells a precisely similar tale. Neither of these men is now remembered by anything beyond the great achievements in chemical science of his early days.

The fact emerges that if science is to retain in its service such a proportion of the most powerful intellectual and creative talent of the empire as will suffice for our progress as a nation, some method must be devised for securing to its followers appropriate emoluments commensurate with those now allocated to the non-productive professions.

This is not only necessary in connection with those purely utilitarian branches of chemical science to which I have already directed attention, perhaps too insistently, for illustrative purposes. A great danger exists at present, and will grow in the future, that the enormous productiveness of experimental science will overshadow the importance of scientific work of less immediate utility. It would be a great calamity if pure science were neglected in favor of the cultivation only of natural knowledge which gave immediate promise of beneficial material results. One of the most important functions of any expression of collective chemical interest such as I have foreshadowed would be to insure that pure unproductive scientific research should be retained on an even higher level than that assigned to immediately productive original investigation.

At the present time physics and chemistry are merging into one; we foresee that the near future will furnish us with still broader views of the universe and will mark a new development more illuminating even than the great advances which followed Dalton's atomic theory and all its nineteenth century sequences. No material interests must be allowed to check this stupendous expansion of our knowledge.

Hardness of Ingot Iron and Copper:—F. C. Kelley in the October, 1918, issue of the *General Electric Review* studies the hardness of ingot iron with a view of producing metal capable of replacing commercial copper where the latter is used merely on account of its softness. The iron tested contained

C	0.05
Mn	0.02
Si	trace
S	0.010
P	0.004

The results of the Brinell hardness tests are tabulated below:

Iron		Copper	
1. Unannealed sheet bar	96.4	Unannealed bar	80.7
2. Annealed at 770 deg. C. for 8 hours in closed pot	79.7	Annealed at 600 deg. C. to dead soft state in gas furnace	40.4
3. Unannealed bar cold rolled, ½ reduction	111.5	Unannealed bar cold hammered, ½ reduction	91.0
4. Sample 2 reannealed in pure hydrogen (Ruder's Anneal) 3 hours at 925 deg. C.	60.4		
5. Ruder's Anneal on sample 1.	61.6		
6. Annealed 2 hours in Arsem vacuum furnace at 1000 deg. C	64.0		
7. Sample 4 cold rolled, ½ reduction	95.7	Sample 2 cold rolled, ½ reduction	91.0

Behavior of Iron Compounds at Extremely High Temperatures:—Following studies of the spectra of iron and its compounds in flames and furnaces, G. A. Hemsalech (*Philosophical Magazine*, Vol. 36, p. 209) concludes that the iron atom is not permanently detached from its compounds by the action of heat. He used a resistance furnace consisting of a heat-insulated carbon tube 14 mm. internal diameter. 3 mm. thick and 6 in. long, clamped between heavy graphite terminals. The iron spectrum appeared in the furnace from 1500 deg. C. to 2400 deg. C. whether metallic iron was present or not, and corresponded to that given by any iron compound fed to the cooler of the following flames:

	Deg. C.
Air-coal gas (cone), less than	1700
Air-coal gas (mantle)	1850
Oxy-coal gas	2450
Oxy-hydrogen	2550
Oxy-acetylene	2700

The spectrum is restricted at lower temperatures. At about 2500 deg. C., the boiling point of iron, a general change in the character of the spectrum occurs.

From the evidence the author concludes that the furnace- and flame-spectra up to about 2500 deg. C. are caused by the partial dissociation of compounds due to heat, and while the orbital motions of its components are changed, the compound retains its individuality throughout. On the other hand, in the explosion region of the air-coal gas flame the iron atom, thanks to its strong affinity for nitrogen, is free during the time necessary to change into a nitride, and the spectrum of this flame shows a high degree of development comparable to that observed in the arc and spark.

Metallurgical Practice on Cinnabar at Idria, Austria*

A Description of the Plant Installation and the Types of Furnaces in Use, Including Shaft, Cermak and Kroupa Furnaces—Condensation of Mercury—Soot Treatment—Production

BY DR. ROLAND STERNER-RAINER

IDRIAN quicksilver operations have withstood the vicissitudes of troubled times for over five centuries. The story of Idria's past has been related to us by conscientious historians, who have shown not only the influence of the world's affairs on its prosperity and development but also the development of its metallurgical practice.[1] In the following will be described not only the current practice but also the improvements which are planned for the near future based upon recent experiments.

The Idrian ore body is associated with the conglomerates and the typically Idrian "Skonzaschichten" (black, bituminous slates and sandstones interbedded in the Wengenerschichten, carrying fossil plants) of the upper Triassic and with dolomite breccias, dolomites and the Guttensteiner limestones of the lower Triassic.[2]

The broken ore, which is hand-sorted in the mine into plus and minus 2 per cent material, is transported to the ore-dressing plant (Fig. 1.) in cars having a capacity of 700 kg.

CRUSHING AND SIZING PLANT

The ore is dumped on a 90-mm. vibrating screen (Seltner patent). The plus 90-mm. material passes to a rock crusher, which discharges on another screen, the fines of which constitute the so-called "armer Erzgries" or low-grade fines. The coarse material is fed to a circular rotating sorting table, from which high-grade ore and material to be recrushed is picked out. This high-grade ore is hoisted and treated with the hand-picked ore coming from the mine. The minus 90-mm. material passes to another screen of 20-mm. mesh, the plus 20-mm. material going to a pickling belt, where ore, wood and waste are separated. The "armer Erzgröb," or low-grade coarse, drops into a bin. The minus 20-mm. material ("armer Erzgries," or low-grade fines) is partly screened through a 4-mm. sieve. The 4- to 20-mm. product and the 0- to 4-mm. product are called "armer Erzgries a and b," and are stored in ore bins. The plus 2 per cent ore is crushed in a small crusher after the large pieces have been hand-cobbed to suitable size. The crushed product passes to a shaking screen equipped with a suction hood to avoid the dust problem. The material passing the screen is fed to crushing rolls, from where the ore passes to a revolving screen of 4-mm. mesh, which completes the classification. The over-size is returned to coarse crushing rolls with a bucket elevator and is screened into two products, which are fed to medium and fine crushing rolls. Both of these rolls feed a revolving screen of 4-mm. mesh, which again gives a coarse and fine product. This extensive crushing of the high-grade ore is believed to insure complete roasting in the furnaces and the consequent avoidance of large mercury losses. The richer the ores are, however, the less crushing is necessary, as the escape of the subliming cinnabar leaves a porous rock, the porosity being greater the richer the ore, so that there is no possibility of the rock entirely enclosing the cinnabar.

The dressing then gives the following product:

	Mercury Per Cent	Mesh Mm.
a. Low-grade:		
1. Low-grade coarse	0.340	20 to 90
2. Low-grade fines	0.468	0 to 20
3. Low-grade fines a	0.440	4 to 20
4. Low-grade fines b	0.815	4 minus
b. Ores containing over 2 per cent Hg:		
1. Fines		4 to 20
2. Dust		4 minus
c. Ores containing over 5 per cent Hg:		4 minus

The ores, which are hauled to the plant by an electric locomotive, are carefully weighed and sampled. Ten grams is taken for an assay sample with low-grade ore, two grams for high-grade ore and 0.5 gram of the very rich material. Kroupa's modification of Eschka's gold cover assay method is used. The moisture is estimated at 2 per cent.

OPERATION OF SHAFT FURNACES

The low-grade ores are burned in eleven shaft furnaces (Fig. 2), two of which have a circular cross-section and are slightly smaller than the others; the capacities are 15 tons in 24 hours for the larger and 13 tons for the two smaller ones. Some of these furnaces are equipped with Spirek's[3] automatic charging device, the others are closed with bell-like charge covers, through which the furnaces are charged every two and a half hours. The operation of the charging device is as follows: The iron hopper is filled with about 600 kg. ore from the charge car, and a load of charcoal (½ cubic meter) or coal (60 kg.) is spread over it. The second charge car is held in reserve and

*Translated from the *Osterreichische Zeitschrift fur Berg- und Huttenwesen*, Vol. 62, 1914, by C. N. Schuette, Metallurgical Assistant, Bureau of Mines. The work was done in connection with a coöperative investigation of the metallurgy of mercury being carried on by the Bureau of Mines and the New Idria Quicksilver Mining Co., by whose courtesy reproduction is permitted.

[1]K. k. Bergdirektion zu Idria in Krain: Das k. k. Quecksilberwerk zu Idria. Zur Erinnerung an die Feier des 300 jährigen auschl. staat. Besitzes, 1881; Karl Mitter: Uber das alte und das moderne Quecksilberverhüttungswesen in Idria, Vortag auf den Bergmannstage in Klagenfurt, 1893; G. Kroupa: Notizen zur Quecksilberbestimmung nach A. Eschka, Jahrbuch der Bergakademien, 1889; Dr. A. Harpf: Der Idrianer-Schüttofen und seine Verwendung zur Verhüttung von Quecksilberzen, Zeitschrift f. angew. Chemie, XVII. Jahrgang; Pilz: Überlick über den Quecksilberbergbau und Quecksilberhüttenbetrieb von Idria in Krain, Berg- u. Hüttenmannische Rundschau, IV. Jahrgang; T. L. Genter: the Quicksilver Mines of Idria, Eng. and Min. Journ., 1903; Franz Castek: Die Bestimmung und Verminderung der Verluste beim Quecksilberhuttenwesen, Jahrbuch der Bergakademien, 1910.

[2]Dr. R. Sterner-Rainer: Das Quecksilberwerk zu Idria in Krain. Paper presented May 9, 1911, in the Freiberger Geologischen Gesellschaft, V. Annual Report, 1912, p. 26.

[3]V. Spirek, Appareil de Chargement sans fumée Congrès international des mines, de la metallurgie, etc., 25, Juni jusqu'à 1, Juli, 1905, Section de metallurgie.

is dumped when the hopper begins to empty, which occurs when the water-sealed charge door cover is opened; the bottom of the hopper on which the charge rests now swings down on a frame which has moved across the charge opening. On closing, the charge hopper cover is replaced, the frame moves back, making room for the charge door cover; at the same time the hopper bottom is raised and the hopper can be refilled. This device works quickly and allows almost no escape of

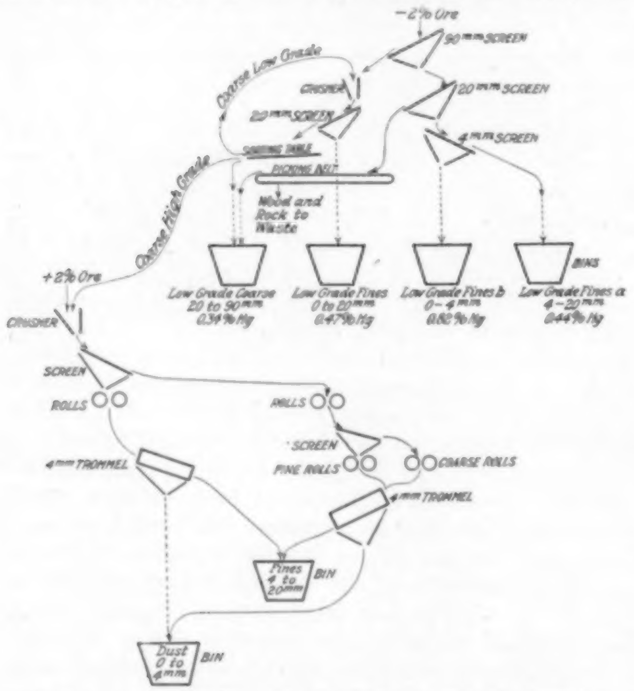


FIG. 1. CRUSHING AND SIZING PLANT AT IDRIA

charge gases and has proven very satisfactory, except that the trough of the water-lock can become clogged with ore or coal and so prevent complete sealing. The covers tend to warp with excessive temperatures and then close the opening imperfectly. A hole is left in the furnace top near the charge door, through which the height of the ore column can be measured with a wooden rod. This hole is stoppered with an oakum-bound iron plug. Generally, a single charge of two or three cars fills the furnace.

At the shaft furnaces, closed with a cone and cover device, the necessary number of charge cars is spotted, each second car being filled with the measured 2½ per cent of fuel. Here also wood and coal fuel are alternated from shift to shift in order to maintain a constant heat. Attempts to replace wood or coal by coke have not favored the latter practice. When the preparations are completed the counter-balanced cover is quickly raised by means of two levers; the cone is raised as soon as the ore has been dumped and the cover is quickly replaced. This operation is repeated until the furnace is filled. If the shaft becomes full, so that the ore no longer flows into it, the cone is replaced as well as it can be, and the circular hopper cover is set into its water seal. During this manipulation, which is quickly completed, some noxious gases escape from the furnace and the correct way of charging with this device would be not to lower the cone until the cover has been replaced and to repeat this process with each car of ore charged to the furnace. This process is far too tedious to suit the workman. The gases above the cone were formerly drawn into a special condenser system, but the only result of this attempt was that the lowered pressure caused a greater flow of gas into the space between the cone and the charge-cover, and for this reason the device has been abandoned as impractical.

The tailings are drawn as fresh ore is charged, cooled with water and returned to the mine for fill. At the first removal of tailings during the morning shift, 10 kg. are taken as a sample, which are tested twice a month. The sample is reduced and about 10 or 20 grams are taken for assay. The tailings content varies between 0.0005 per cent and 0.0025 per cent. The crew is five chargemen and five drawmen. The shaft furnaces treat 42 per cent of the ore and their extraction equals 92.37 per cent of the contained mercury (loss 7.63 per cent).

Operation of Cermak Furnaces

The low-grade fines are treated in three old Cermak-Spirek fine-ore furnaces and one new and modified furnace of this type, which is fired with producer gas. The first Cermak fine-ore furnace erected in Idria was equipped with a "generator" at the ends of the furnace. These generators, which, in construction as well as in operation, resembled "semi-gas producers," were not a success and were later replaced by grate fires, which system is still prevalent in the plant. Because of the importance of gas fuel to quicksilver metallurgy, a new solution of this problem was undertaken at the instigation of H. O. Kroupa, despite the former failure. The encouraging results will be discussed later on. Each of these older furnaces is really a combination of four 10-ton furnaces which have been joined in order to achieve a more efficient use of heat. Every 2½ hours, or three times per 8-hour shift, the tailings are drawn into an iron car. These are sampled with a long-handled scoop; the sample is reduced, mixed with hammerscale and heated for ten minutes (measured with an hour glass) over an alcohol flame. A completely burned charge should not give the faintest mirror of quicksilver on the enameled water-cooled cover of the

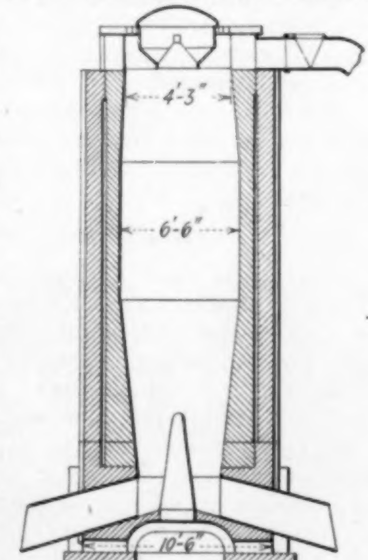


FIG. 2. VERTICAL SECTION OF NOVAK SHAFT FURNACE

crucible. If no mirror is deposited, the tailings, which at most can contain 0.005 per cent Hg., are drawn into cars and hauled by a 10-hp. gasoline locomotive to a rock bin which is situated over a sluice leading to the Idriza River. After drawing, a corresponding amount of ore can be charged. The capacity of Nos. 1 to 3 furnaces, which are fired with beech or fir wood or with brown coal, is 45 tons of ore. Since one furnace block (that is, four shafts) has eight draw doors, eight cars at 0.5 tons each being drawn every 2½ hours, the same amount being charged, the ore remains in the furnace full 32 hours. The charged material is evenly spread about over the topmost furnace tiles with rakes. Since as in Italian practice the

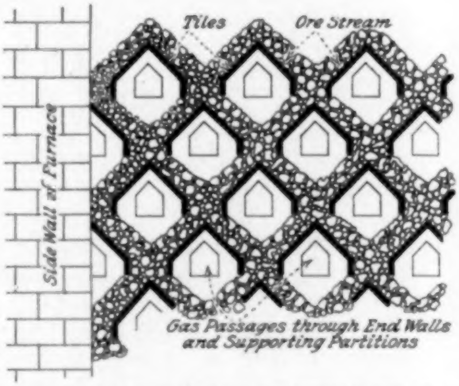


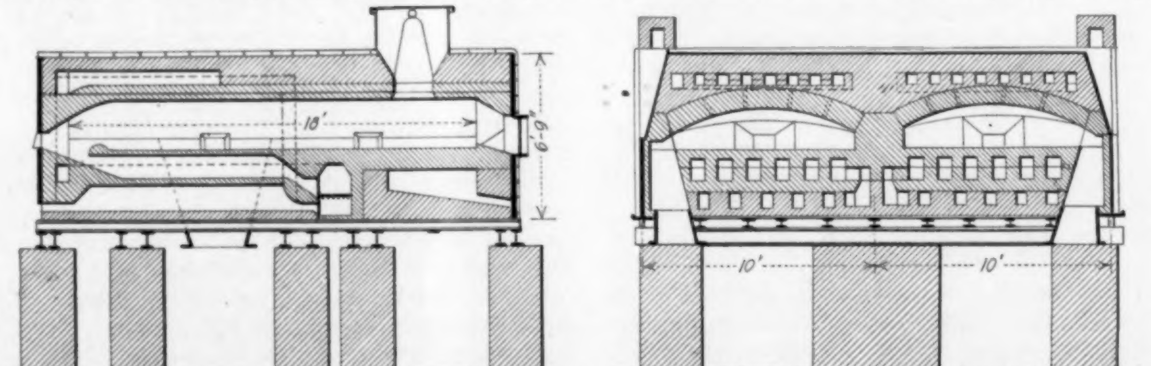
FIG. 3. CROSS SECTION SHOWING TILES IN CERMAK FURNACE

upper row of tiles is not connected with the furnace flue, and since the charge gases rising between the upper tile the roofs pass out through their own condenser system, the charge floor remains free of gas because the greater draft draws off the gases from beneath the upper gable. This also serves to remove the moisture which would otherwise condense on the charged ore. Even when the upper row of tiles becomes uncovered there is little evidence of escaping gas. As noted, these furnaces treat about 45 tons of low-grade fines per 24 hours, while broken tile in the furnace reduces the capacity to 40 tons. Such furnaces are charged with dustless fines, which it treats more advantageously and quickly.

In order to relieve the reverberatory furnaces treating minus 4-mm. ore, a gas-fired fine-ore furnace of 80-ton capacity was built a year ago. With this furnace it is unnecessary to screen the low-grade fine ore, as it will even treat the dust successfully. The space between tiles (see Fig. 3) was fixed at 80 mm. instead of at 100 mm., as is customary in the old furnaces. Since gas fuel is used, the roasting zone in this furnace is increased, thus increasing the capacity. The furnace has ten rows of superposed gables with the same over-all height of the old six-gable fine-ore furnaces; for this reason the gables were made slightly flatter. Each of the four furnace shafts is divided into three parts by two walls, so that each gable, likewise divided into three tiles, can the more easily and cheaply be replaced if damaged. The two upper gables, which are made of cast iron, are kept under a greater draft than the other parts of the furnace. The two lower gables, which serve to preheat the air, are not heated except by descending hot ore. The flame may be regulated according to requirement and the feed of the producer gas may be regulated by suitably placed dampers.

The gas producer was originally designed for coal and wood, but was soon changed to an all-wood feed because of excess clinkering. Supt. Slavik has successfully managed not only to dispose of the enormous development of wood tar by an improved condensation system, but has also devised a system by which one cord of wood can be charged into the generator at a time. The furnace results with producer-gas firing are satisfactory in every respect. The capacity of the furnace is now 85 tons per 24 hours, nearly 100 per cent greater than that of the grate-fired furnaces. The wood consumption per ton of ore treated (0.14 cubic meters) is no greater than before. Above all, the gas fuel not only causes a richer soot to form in the condensers (the soot being only slightly contaminated with tar and dust) but about half of this mercury is recovered as free metal. Less soot forms than formerly, which is beneficial not only from an economic but also from a hygienic viewpoint. For these reasons it is proposed to construct another of these furnaces of doubled capacity.

By the use of producer gas the temperature in any of the 12 gable rows can be raised to any desired degree, as each of the gable rows can be heated individually. The flow of gas and air can be so regulated by means of dampers that a constant difference between the temperature of the roasting gases and the temperature of the ore can be maintained. According to Dennis[4] an even fall of potential of this kind increases



Longitudinal Section Cross Section

FIG. 4. WOOD-FIRED REVERBERATORY FURNACES

[4]*Engineering and Mining Journal*, 1909, No. 3.

the speed of the heat transfer in the furnace, so that a saving of time and fuel should result. Since the flow of air and gas can be completely controlled, the draft can be increased so that suction can be maintained even in the lowest row of gables, causing air to be drawn into the peepholes rather than letting gas escape from them. Not only can this regulation determine the speed of the gases through the condenser system, but the air around the furnace will be purer and healthier for the workmen.

The new furnace, which will be one meter higher than the others and have an automatic draw and the usual iron sheathing, will also be employed in furnacing low-grade fine ore.[5] In the future, a system of conveyor belts will feed all furnaces.

The fine-ore furnaces, which treat about half the tonnage, give an extraction of about 88.39 per cent of the input, while the small fine-ore furnace, which treats the high-grade fines (6.63 per cent Hg), works with a loss of 8.34 per cent.

The six bottom-fired reverberatory furnaces are to be discarded, since better methods for treating the fine material have been developed. Last year 8 per cent of the tonnage was treated in these furnaces with a loss of 10.14 per cent of the input. Since low-grade dust, low-grade soot and pressed soot, however, will be treated in these furnaces for some time to come, they shall be briefly described. Fig. 4 shows these wood-fired reverberatory furnaces. The fuel consumption is 3 cubic meters of beech wood in 24 hours; this quantity is considerably less with very rich ore (over 50 per cent) as the combustion of the sulphur gives considerable heat independently of the heat from the fuel. The furnace will treat 7 tons of low-grade fines per 24 hours, but only half this tonnage of high-grade fines or soot; thus 4.3 per cent of wood is needed for low-grade material and twice this amount with rich material. The charge is moved every half hour with a long iron rake, and after three hours (longer with rich material) it is moved to a space in front of the fire arch which has been cleared by the removal of the former charge. One charge car of low-grade or a half car of high-grade material is now charged through a cone and cover charging device. A quarter of an hour before drawing the tailings a sample is taken from the center of the hearth by inserting a suitable shovel which is introduced in-

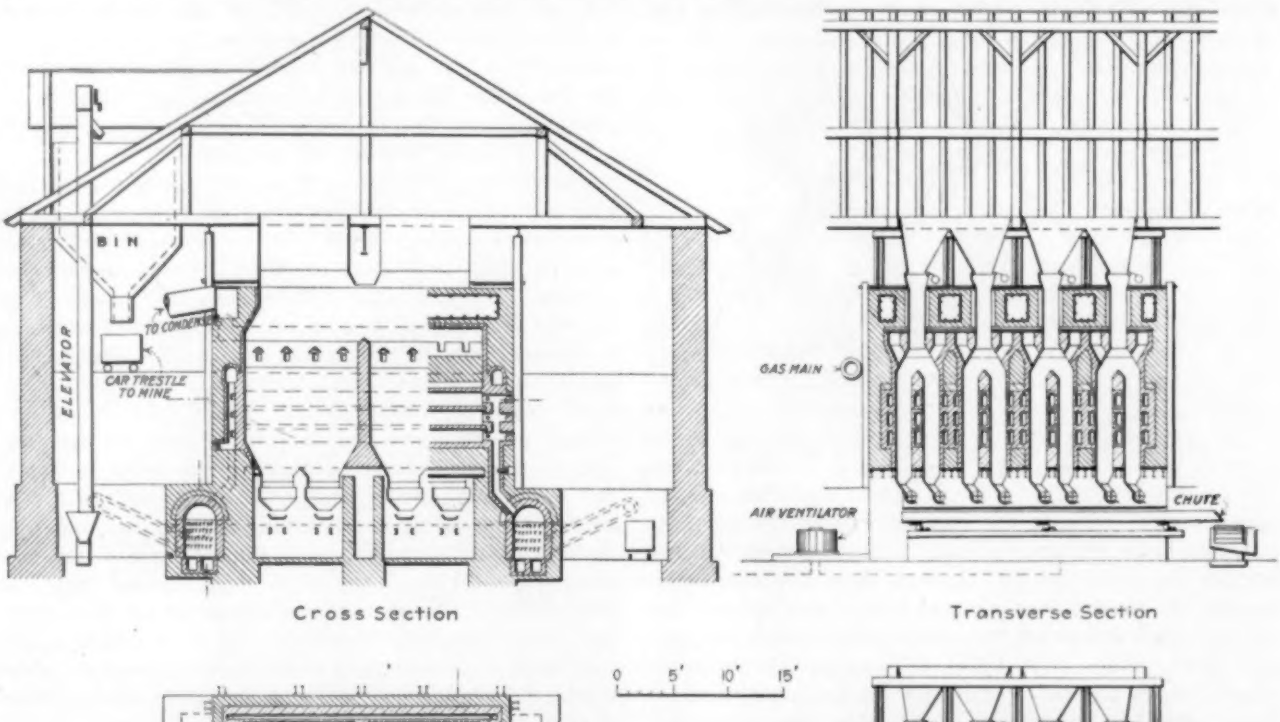


FIG. 5. KROUPA'S FURNACES FOR INDIRECT REGENERATIVE GAS FIRING

[5]The furnace is already in operation. The results are as predicted, the capacity being 140 tons, and this may be increased later.—EDITOR.

verted and then turned over. This sample is tested as already described; if no mercury mirror is shown, the tailings are drawn into iron cars and transported hot to the dump, where an automatic device discharges them into a sluice. The burned soot is used over again to press fresh soot.

Kroupa's Shaft Furnace

Encouraged by the favorable results achieved by producer gas fuel, the Idrian plant will make an attempt to treat the coarse ore by a method superior to that of burning in the shaft furnaces. In the coming year Kroupa's patented shaft furnace will be erected, which it is hoped will be a further step toward the perfecting of quicksilver metallurgy (Austrian Patent No. 62,517). The fundamental idea of this furnace construction is to sublime the cinnabar between highly heated walls, then burning it by allowing a sufficient amount of oxygen to enter, and finally condensing the free mercury. The column of coarse ore in the shaft is relatively narrow and allows a free passage of gas. The heat, which is derived from the combustion of producer gas, is utilized as efficiently as possible, and losses by radiation are avoided by reducing the radiating surface. This also lessens the diffusion of mercury vapor into the walls. The separation of the gases of combustion and the mercury fumes must result, first, in an almost complete condensation of the mercury, and, second, in a minimum formation of soot (or dust and bitumen). At the same time the saving of space will result in less labor being needed, and the greater tonnage handled will result in lower maintenance charges.

In the execution of these fundamental ideas the furnace was given the general shape of a cube having a length, width and height of about 9.3 meters, the regenerators being built along two sides (see Fig. 5). In this cube are eight vertical parallel shafts separated by walls built of refractory masonry and containing the heating flues. The shafts are 0.5 m. wide and 7.35 m. long and, including the charge shaft common to two roasting shafts, are 6 m. deep. The roasting zone formed by the heating flues has a height of 1.5 m. Each shaft is divided into two symmetrical parts by a transverse wall 370 mm. thick, located at its center. The ore is charged through a gas lock into the common shaft; on descending is divided into two streams by a gable-like edge and descends through the roasting zone in two columns, each 500 mm. thick.

The oxygen necessary for the combustion of the cinnabar vapor enters through an automatically controlled opening connected with the operation of the automatic draw machinery and is gradually heated to the temperature of the roasting zone. On leaving the roasting zone the gases preheat the descending ore in the charging shaft, so that the gases are fairly cool when entering the condenser.

The walls of the roasting shafts are heated by leading producer gas into the heating flues, where it mixes with the preheated air from the regenerator and burns. The discharged heating gases are led into the opposite regenerator, and when this is sufficiently heated the flow of both air and gas is reversed. This effects an even heating of both sides of the shaft and an even roasting of the charge. Judging from experiments at the Zinkhütte Cilli and experience with gas-fired fine-ore furnaces, this furnace should have a greater capacity than that of the present shaft furnaces combined, and the method of treatment is very much simpler.

Condensation of Mercury

The metal-bearing gases pass from the furnace to the condensers through cast-iron pipes. The Cermak condensers (Fig. 6), consisting of straight and curved stoneware pipes, or more recently of glazed tile, following a suggestion of H. Auhagen, have a short leg extending from the bottom of the U into a water-filled soot box. The inverted U is closed by a stoneware cover lying in an annular water-filled trough. A shaft or a reverberatory furnace has four lines of condensers, a fine-ore furnace eight or nine (the new one is to have fourteen). They are sprayed with water as evenly as

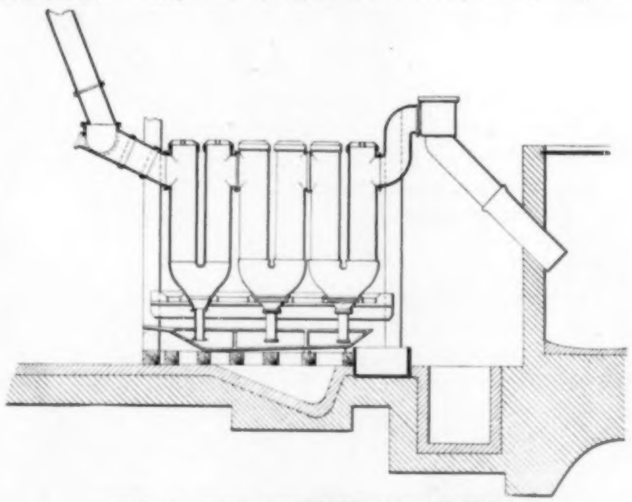


FIG. 6. THE CERMAK CONDENSERS

possible in order to cool the furnace gases. To keep the cooling water out of the soot boxes the condenser pipes stand in a large cup, only the short lower leg extending into the soot box. The extra condensers for drawing off the water vapor from the upper part of the fine-ore furnaces are similarly arranged. This line of condensers, fed by a separate exit pipe, consists of only two vertical pipes, which accounts for the greater draft. The exit pipes from the furnace must be made of iron, as they must resist a high temperature and great temperature variations. They are very resistant and may last twenty years. With even cooling and the avoidance of careless handling, stoneware (or still better, glazed tile) is the most resistant of materials. Cracks are filled with cement and the two parts are bound together with iron hoops, since leaks must be stopped immediately to avoid large mercury losses. The cooled gases leave the stoneware pipes, in which they deposit the greater amounts of mercury, soot, tar, ore dust and water, and pass into chambers (often common to several furnaces) divided into several parts by transverse walls. These transverse walls by forcing a change in direction of the gas stream effect a more complete settling of the dust.

The chambers and flues are made of tarred wood throughout, as this most easily resists the action of the gases. The individual boards forming the walls are held in place with wooden screws and are luted with tar. Since a considerable amount of rich soot gathers

in the first chamber, this is hoppered into a soot box, so that the chamber can easily be cleaned. Each of the chambers can be cut out by means of dampers. A 16-hp. exhauster having copper vanes and a capacity of 7 cubic meters of gas per second is built into the flue and gives a draft of 80 mm. of water.

It is also proposed to abandon the central subterranean condensation chamber, as it is not easy of access and the detection and repairing of leaks correspondingly difficult. The purpose of this chamber was to collect the damp, poor grades of soot called "arme Kammerstupp." The 14-m. stack which stands 146 m. above the general plant level will be removed and replaced with a 30-m. stack with a Wislicenius top. It still remains to be seen whether the Cottrell precipitator will be effective in condensing the residual bits of soot and mercury. The method is excellent for collecting dust, wet dust and liquid globules, though in the latter application it is difficult to insulate the electrodes. These difficulties might even be greater in collecting soot, but are probably not unsurmountable. Without doubt the improvements in quicksilver metallurgy must be sought for in the process of condensation, as the perfection of furnace construction has improved the roasting process enormously.

Soot Treatment

The shaft furnaces which treat only low-grade but nearly dustless ores give a little very rich soot, which is cleaned up every two months. The soot derived from the low-grade fines and the low-grade fines a is cleaned up each month; the soot derived from the high-grade fines and from burning rich dust and pressed soot in the reverberatory furnaces is cleaned up every fourteen days. The condensers of the reverberatory furnaces burning low-grade fines and furnace debris are cleaned up each month. Clean-ups are not needed oftener than every two weeks, even if 50 per cent ore is burned in these furnaces, as this does not form any additional soot and the mercury can be drawn from the traps into cast-iron pots without removing the soot. The collected mercury is dried with wood ashes and poured into storage flasks. This is also done before the clean-up at such other furnaces as yield a sufficient amount of free mercury. Since the mercury is mixed with the soot, it is necessary to agitate the latter in order to free the mercury. After the soot has been taken out of the soot boxes additional mercury can be drained off. No fuel is added and no ore is charged during the clean-up, to prevent mercury fumes from escaping and injuring the workmen. The condenser line to be cleaned is cut out of the furnace draft with dampers, the gases meanwhile passing through the other lines. The cement luting of the covers and cleanout holes of the pipes are cut away with sharp irons, the covers are removed and the soot swept into the boxes beneath with long-handled, double-faced brushes. The water in the soot boxes is siphoned off on the side away from the furnace and flows through gutters in the concrete floor to settling boxes and sumps, where any mercury in suspension may settle before the water flows to waste. The soot boxes are emptied, starting from the furnace side, the soot being dipped into buckets standing on a sheet-metal saucer to prevent spatter losses, long-handled dippers called "Gatzen" being used. As the soot becomes very liquid after a part of it has been removed, burned pressed soot is added to thicken it, and finally the box is cleaned with these dry soot rejects.

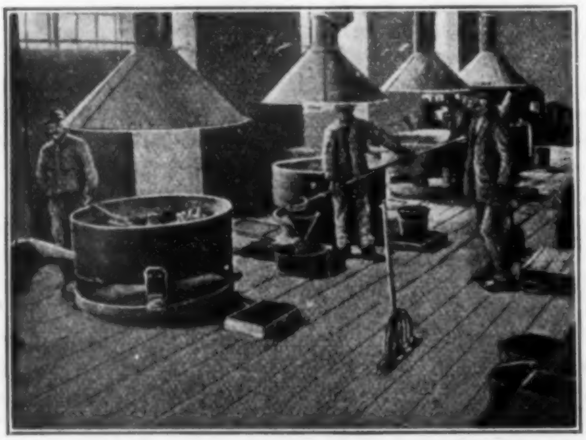


FIG. 7. OLD SOOT PRESS

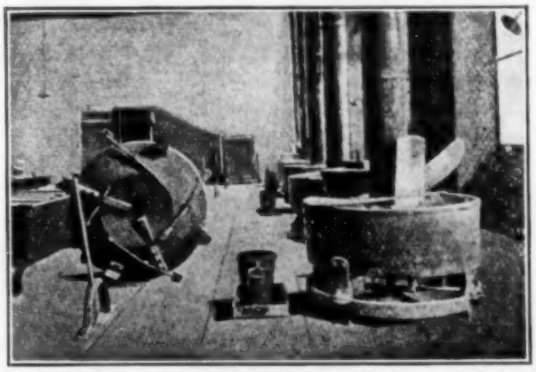


FIG. 8. NEW SOOT PRESS

Small amounts of metallic mercury are found in the soot boxes of even those furnaces treating very low-grade ore. If of considerable quantity it is poured into storage bottles; if not, it is dipped into the bucket with the soot. The filled buckets are taken to the soot mill in lots of six on a small iron flat car. A so-called "main clean-up" is held once annually, generally in July, during which the plant operation is entirely suspended, the furnaces repaired and the entire condenser system cleaned, including even the stack flue.

After the main clean-up the pipe soot and the rich chamber soot are put into boxes of about one cubic meter capacity, where they are allowed to settle. After a few days the clear water is siphoned off and the soot put into buckets and taken to the soot presses. Some metallic mercury always settles out on the bottoms of these boxes, and this mercury is poured into storage bottles holding about 60 kg. each; these are carried to the scales. An iron ring is placed in the box to facilitate the removal of metal; the soot in the ring is skimmed off, when the clean mercury, which enters between the ring and the bottom of the box, is dipped out.

One bucket of poor soot containing about 10 liters is generally sufficient for one soot-press charge (Figs. 7 and 8). With rich soot, which, however, is mainly metallic mercury, several buckets may be charged at once. When the press has been cleaned of the previous charge, a scoopful of lime is spread in it, the charge of

soot is added and covered with about three shovels of lime or burned soot rejects, and the machine is started. When the material has been well stirred additional lime is added until the mass becomes consistent; the time will depend on the moisture content and softness, but generally this stage is reached in half an hour. Most of the mercury is separated in about five minutes. To protect the workmen from mercury fumes, quicklime dust and the soot odor, the soot press is completely closed with a hinged cover containing a little charge hopper for the lime. The drain slots, on becoming clogged with soot, are cleaned by means of a mechanism which is actuated by a foot lever. Additional quicksilver flows out of the soot after each addition of lime, at first every two or three minutes, and later every four to six minutes. It gathers in the lowest part of the press and escapes through slots into a dish beneath, from which it runs to cast-iron pots, and is poured from time to time into storage bottles, which are taken to the weighing room. After pressing for about one hour (the pressing is really a mixing and continual cutting of the consistent mass), additional lime is added. The material then consolidates into lumps up to hazelnut size and yields no further mercury, which ends the pressing process. The soot press is now cleaned with a small, flat, chisel-like shovel, the walls and knives being scraped clean. The scrapings are removed with a scoop used to feed the lime. The pressed soot, consisting of dark to light gray nodules, is weighed and transported to the reverberatory furnaces to be furnaced as rich ore, as it contains from 20 to 30 per cent mercury. Medium moist soot needs about thirty parts of lime to one hundred parts of soot. The soot presses are operated for one eight-hour shift per day. One press treats six or seven charges, although it could handle more; one operator per press is needed.

It has been tried to remove mercury from soot by centrifuging, but these experiments showed that in this process the soot consolidates into a hard mass without yielding its mercury. If, however, this treatment is preceded by a treatment with hot hydrochloric acid or by an extraction with carbon bisulphide, chloroform or ethyl acetate, the greater part of the metal will run together by centrifuging. The fundamental principle in the treatment with acid is the same as that employed in the soot presses. Instead of the saponification by means of the lime, which cleans the metallic particles of mercury from the adhering distillation and combustion products, we have in this treatment an acid saponification, while fats and oils are removed with the ether wash. This cleansing process allows the minute, disseminated particles of mercury to unite.

Shipment and Production

Quicksilver is shipped in wrought-iron flasks holding 34.5 kg. Flasks destined for the Transvaal contain only 34 kg.; these flasks are designated with a red "T" and by being marked with red instead of white paint. The metallic mercury coming from condensers, soot boxes and soot presses is poured from oakum-stoppered storage bottles into an elevated iron pot. A drain pipe leads from the pot to a cylindrical clay weighing bucket with a conical bottom ending in an iron stop-cock, to which a hose is attached. When the beam balance points to zero the stop-cock is closed, the mercury is accurately tared, and this mercury is run into the iron shipping flasks, which are then closed with a greased iron stopper. The flask is held in a vise while the stopper is screwed in. To test the shipping flasks for leaks they are inverted in an iron pan. If no leaks are found, it is ready for shipment. Some customers desire to receive their mercury in leather bags. For these it is filled in oiled sheepskin bags holding 25.08 kg. (55 lb.), two of these bags being shipped together in a small wooden keg.

The plant, which during the past year treated 117,-110 tons of material, produced from these 762.5 metric tons (22,400 flasks) of metallic mercury.* Upon completion of the proposed improvements and plant additions, the production will probably increase considerably.

Who and What Is the Employment Manager?

By C. T. Clayton

Director, Training and Dilution Service, United States Department of Labor

As modern business organization increases in complexity, further division of responsibility and more closely defined delegation of authority must be extended or the management will become chaotic. It is being recognized more and more that one most important function in a well-organized industrial establishment is the hitherto neglected responsibility of selection, placing and advancement of workers. This is what we mean by the term "employment management."

Employment management goes further, however, than merely concerning itself with such selection, placement and promotion. It investigates, as part of the selection, the character, experience and capacity of the applicant. It investigates for placement, and does not limit its investigation to the applicant. It sounds possibilities of openings for placement and it employs every means to secure the comfort and safety of the worker and thus assists his advancement by giving him a quiet mind and an assured future.

The employment manager is really the conscience of modern industry in practical action. In the old days, when employers had but few workers and themselves worked side by side with them, every worker was individually known to his boss, his idiosyncrasies were understood, his ambitions were appreciated because they were similar to the boss's ambitions. But now, when workers, numbered by the thousands, are employed by a collective boss who is a mere list of stockholders, living perhaps thousands of miles from the works and knowing the workers only as items of profit or loss on a ledger, some substitute for the old personal touch must be found or industry will become, first, congeries of unrelated items in reports, and, finally, mere anarchy. If modern industry is to be well-knit, is to understand and accomplish its real purposes, it must cultivate its conscience—the employment manager.

The usual method of business organization unfortunately has so far failed to take in this function as a distinct part of factory control. The foreman should not be charged with responsibility of selection of his gang. Good management does not require that he do so. Fac-

*Recovery, 6.5 kg. (14.3 lb.) per metric ton ore.

tory after factory has demonstrated that if the foreman's power includes that of sending back an unsatisfactory worker to the employment manager for removal and replacement, that is sufficient for purposes of discipline. But when it is considered that the cost of securing and training each worker ranges from $10 to $200, and averages probably more than $60 each, a stupendous leak in the business which still clings to the antiquated foremanship hiring-and-firing methods is disclosed. Moreover, competent employment management reduces industrial misunderstanding and friction quite noticeably. In these days, when every nerve must be strained to obtain the highest possible output, no wise factory manager will ignore such a means of keeping the industrial peace.

Employment management differs from the public employment service. Some employers have been limiting their employment management to the status of mere labor recruiting agencies. That work should be left to the United States Employment Service, whose function is to find the labor and sift it in a preliminary way, offering those workers who seem likely to suit to the employment manager for his more intimate knowledge of the factory's needs, his more thorough methods of selection. The employment manager cannot be dispensed with in favor of the public employment agency any more than the public employment agency in this day of national need can be evaded. At least twelve millions of our working people are today engaged in the production and distribution of war supplies behind our military forces. Six millions or more will be required to fill the toll of increased demand brought about by the call of two millions to the colors before next July. Every available new source of labor must be tapped and carefully selected and trained before placing in industry.

War Emergency Courses in Employment Management

An intensive training in employment management for men and women having a basic experience of at least three years' industrial experience and knowledge of factory methods has been arranged for in the following cities:

Boston—Harvard University, Massachusetts Institute of Technology, Boston University. New York—Bureau of Municipal Research. Rochester—University of Rochester. Pittsburgh—Carnegie Institute, University of Pittsburgh. Seattle, Wash.—University of Washington. Berkeley, Cal.—University of California. Courses are in preparation in Cincinnati at the University of Cincinnati, and in Chicago at the University of Chicago.

The courses, which run from six weeks to two months, are conducted by the Employment Management Division of the War Industries Board under the auspices of the Department of Labor, the War Department, the Navy Department, the United States Shipping Board and the Chamber of Commerce of the United States. There is no tuition fee. Employers having candidates for the courses and individual applicants desiring information should address Capt. Boyd Fisher, Employment Management Division, War Industries Board, 717 Thirteenth Street, N. W., Washington, D. C.

New Jersey Chemical Society

At a meeting of chemists held at the Newark Technical School Monday evening, Oct. 28, action was taken in the matter of forming a permanent organization to promote the welfare of chemical industries and encourage the collegiate education of chemists in the State of New Jersey. The meeting was attended by more than fifty representative chemists of the state and assurance of coöperation and interest was given by forty-five others who were unable to attend. The title chosen for the organization was the New Jersey Chemical Society.

The first regular meeting for election of officers was held in the large auditorium of the Newark Technical School on Monday evening, Nov. 11. Applications for membership may be filed at future meetings. A constitution was adopted, and provision has been made for two classes of membership—firm members and individual members. It was the unanimous opinion of the meeting that this would insure for industrial chemists, for industrial corporations and for educational institutions in the state that close coöperation which will be so necessary in the development of the industries after the war.

The objects of the new organization as set forth are:

1. To provide opportunity for the periodic interchange of ideas relating to industrial chemistry.
2. To support, encourage and promote the general welfare of those industries of New Jersey which use chemicals and chemical processes.
3. To provide state commissions and municipal officials with competent guidance in problems of stream pollution, sewage disposal, water supply, fire prevention, pure food and health control, garbage disposal and street paving materials.
4. To provide a source for technical data relating to public utilities in order to promote the welfare of the State of New Jersey.
5. To further chemical education and provide standards of training for chemists in New Jersey.
6. To insure the permanency of chemical industries in the state by encouraging thorough collegiate training of chemists and providing a means of communication between chemical-industrial plants and our educational institutions.
7. To provide a means whereby banking institutions, investors, boards of trade and other commercial bodies may secure competent chemical advice.

The committee on organization consists of: Dr. Daniel R. Hodgdon, Newark Technical School; Dr. F. J. Pond Stevens Institute, Hoboken; Prof. Ralph G. Wright, Rutgers College, New Brunswick; H. B. Baldwin, chemist to the Board of Health, Newark; Carleton Ellis, consulting chemist, Montclair; Frederic Dannerth, consulting chemist, Newark; W. A. Lucas, the Butterworth-Judson Corporation, Newark; John Cawley, the Beckton Plant, du Pont Co. Newark; W. C. Stobaeus, the Charles Cooper Company, Newark; G. A. Prochazka, manufacturing chemist, Newark; James M. Reilly, the Board of Trade, Newark; Spencer Marsh, the National Newark & Essex Banking Co.; George T. Cottle, A. A. Wire Co., Inc., rubber covered wire; G. A. Armstrong, Central Dyestuff & Chemical Co.; W. E. Hadley, Clark Thread Mills, textile manufacturers; D. K. Howard, department of chemistry Newark Technical School; C. K. Simon, Dye Products & Chemical Co.; R. P. Calvert, du Pont de Nemours Co., Arlington; William A. Richey, National Carbon Co., Jersey City; S. Skowronski, Raritan Copper Works, Perth Amboy; C. L. Foster, Stubner Chemical Works, Elizabeth.

Aluminium and Its Light Alloys—VI. Bibliography (a)

BY PAUL D. MERICA

The following Bureau bibliography on aluminium and its light alloys is the supplement to the very comprehensive one assembled by the library of the United Engineering Societies and presented to the Bureau by Professor Zay Jeffries.

The numbers are references from the previous articles on the technology of aluminium in our issues of Aug. 1; light aluminium alloys, Aug. 15; miscellaneous alloys, Sept. 15; and Duralumin, Oct. 1.

No. Date

REFERENCE BOOKS

1 Aluminum Co. of America, Pittsburgh, Pa., Aluminum electrical conductors.

2 1916 Smithsonian Physical Tables.

3 1915 British Aluminum Co., Aluminum facts and figures, p. 56.

4 1914 Krause, H., Das aluminium.

5 1912 Landolt - Börnstein - Roth, Physikalisch - Chemische Tabellen.

6 1912 Pitaval, R., Die elektrochemische Industrie Frankreichs, pp. 69/84.

7 1912 Flusin, G., L'industrie de l'aluminium.

8 1911 U. S. Geological Survey, Washington, Mineral Resources of the U. S. 1910—Part I, Metals, pp. 722/723.

9 1909 Gmelin-Kraut, Handbuch der anorganischen Chemie.

10 1909 Aluminum Co. of America, Pittsburgh, Pa., Methods of working aluminum.

11 1909 Aluminum Co. of America, Pittsburgh, Pa., Alloys of aluminum.

12 1909 Aluminum Co. of America, Pittsburgh, Pa., Properties of aluminum.

13 1909 Aluminum Co. of America, Pittsburgh, Pa., Fabricated aluminum.

14 1908 Richards, J. W., Metallurgical calculations, part 3, p. 362 et seq.

15 1908 Borchers, W., Electric furnaces, The production of heat from electrical energy and the construction of electric furnaces, pp. 5/27; 210/211.

16 1905 Minet, Adolphe, The production of aluminum and its industrial use.

17 1905 Goldschmidt, H., Aluminothermics, International Electrical Congress Transactions, Vol. 2, p. 85.

18 1904 Buck, H. W., Use of aluminum as an electrical conductor, International Electrical Congress Transactions, Vol. 2, p. 313.

19 1904 Schobel, C., Handbuch der Metallhüttenkunde.

20 1903 Winterler, F., Die Aluminum-industrie.

21 1902 Minet, Adolphe, Die Gewinnung des Aluminiums und dessen Bedeutung für Handel und Industrie.

22 1897 Pittsburgh Reduction Co., Aluminium and aluminium alloys.

23 1897 British Aluminium Co., Ltd., Notes on aluminium and its alloys.

24 1896 Waldo, L., Aluminium bronze seamless tubing.

25 1890 Richards, J. W., Aluminum: Its history, properties, incl. its alloys.

COMMERCIAL ALUMINIUM

26 1918 The Aluminum Industry in 1917, Engng. & Min. Jour. 1918, p. 67, Jan. 15.

27 1915 U. S. Geological Survey, Mineral Resources of the U. S., p. 166.

29 1910 Sheet aluminium, its advantages, Metaux et Alliages, Dec. 1910, p. 161.

COMPOSITION

30 1916 Clennell, J. E., Estimating metallic aluminium in aluminium dust, Engng. & Min. Jour., Vol. 102, pp. 309/310.

31 1916 Withey, Analysis of aluminum and its alloys, Journ. Inst. Metals, Vol. 15, p. 207.

32 1913 Czochralski, J., Chemical analysis of aluminium, Z. anorg. Chem., Vol. 26, pp. 501/503.

33 1913 Boulanger, C., and Bardet, J., Presence of gallium in commercial aluminium, and its separation, C. R., Vol. 157, 1913, pp. 718/19.

34 1909 Kohn-Abrest, E., Analysis of aluminium; direct determination of metallic aluminium; Ann. Chim. Anal., Vol. 14, 1909, pp. 285/289.

35 1909 Delachanal, B., Gases occluded in common metals, C. R., Vol. 148, 1909, pp. 561/63.

36 1908 Kohn-Abrest, E., Analysis of powdered aluminium, C. R., Vol. 147, 1909, pp. 1293/96.

37 1902 Goldschmidt, Silicon content of aluminium, Z. Elektrochemie, Vol. 8, 1902, p. 123.

38 1902 Haber and Geipert, On the silicon content of aluminium, Z. Elektrochemie, Vol. 8, 1902, pp. 163-4.

APPLICATIONS

39 1917 Richards, J. W., Aluminum, Met. & Chem. Engng.

40 1916 Reinhold, O. F., Modern developments of the aluminium for automobile motor construction, troplater, Vol. 11, 1916, No. 5, pp. 127/131.

41 1915 Sherbondy, E. H., Analyzing heat flow; use of aluminum for automobile motor construction, Automobile, Vol. 33, Nov. 4, 1915, pp. 834/35.

42 1915 Clayden, A. L., Aluminium in automobile chassis, Automobile, Vol. 33, Aug. 19, 1915, No. 8, p. 330.

43 1915 Aluminium in the gas industry, J. Ind. Engng. Chem., Vol. 7, March, 1915, pp. 255/56.

44 1915 Pannell, E. V., Recent developments in aluminium, Metal Industry, (N. S.) Vol. 13, Nov., 1915, pp. 453/55.

45 1915 Richards, J. W., The engineering uses of aluminium, Trans. Intern. Engng. Congress, 1915, Advance copy, 17 pp.

46 1915 Ruder, W. E., Calorizing metals, Trans. Am. Elect. Chem. Soc. 27, p. 253.

47 1914 Schipper, J. Edward, Aluminum—a featherweight, The Automobile, Vol. 30, March 26, 1914, pp. 673/77.

48 1914 British Aluminum Co., Ltd., Progress of aluminium, Bull., 144.

49 1914 Aluminum in automobile industry, Metaux et Alliages, Vol. 7, p. 7; J. Inst. Metals, Vol. 12, p. 295.

50 1913 Anonymous, Aluminium foil, Engr., Vol. 116, 1913, p. 199.

51 1912 Anonymous, Report to the French Government by M. St. Germain on "aluminium coinage," Jour. du Four Electrique, Vol. 21, 1912, p. 148.

52 1912 Seligman, Rich., Modern uses of the metal aluminium, Sci. Amer. Suppl., Vol. 73, June 29, 1912, No. 1904, pp. 405/07.

53 1911 Aluminium as a material for jigs, Amer. Machinist, May 25, 1911, p. 959.

54 1911 Non-ferrous materials in Railway work, J. Inst. Metals 1911, Vol. 6, pp. 74/135.

55 1909 Echevarri, J. T. W., Aluminium and some of its uses, Jour. Inst. Metals (London), Vol. I, 1909, No. 1, pp. 125/143. Discussion, pp. 144/163.

56 1907 Fournier, Industry of Al-foil, Nature (Paris), Vol. 35/II, 1907, pp. 147/50.

57 1906 Aluminium paints, Paint, Oil and Drug Rev., Aug. 15, 1906, p. 30.

58 1906 Aluminium sheets as book-making material for blind persons, Archiv. f. Buchgewerbe, Vol. 43, 1906, p. 425.

59 1905 Bichel, C. E., Aluminium in explosives, Z. anorg. Chemie, Vol. 18, 1905, pp. 1889/92.

60 1904 Simon, Use of aluminium for weaving appliances (as a substitute for wood), Rev. Industrielle, Vol. 35, 1904, pp. 185/86.

61 1902 Weiss, R., Discharges with powdered aluminium and magnesium in tissue printing, Bull. Soc. Ind. de Mulhouse, 1902, No. 2, pp. 4-6.

62 1902 Pastrovich, P., Use of aluminium in the stearine industry, Chem. Rev. Fett.-u. Harz-Industrie, Vol. 9, 1902, No. 12, pp. 278/79.

63 1901 Blake, The use of Aluminum in the construction of instruments of precision, Trans. Amer. Inst. Min. Engrs., Vol. 18, 1901, p. 503.

64 1897 Hunt, Utilization of Aluminum in the arts, Journ. Franklin Inst., Vol. 144, 1897, pp. 81/113.

65 1895 Yarrow, A. F., Aluminium for construction purposes, such as building torpedo boats, etc., Inst. Naval Architects, Abst., Engng., Vol. 59, 1895, pp. 470/72.

66 1894 Hart, Notes on the application of aluminium for naval construction, Mem. Soc. Ing. Vivils de France, Vol. 47, 1894, p. 601.

ELECTRICAL

67 1916 Wyssling, Prof. D., The use of aluminium for electric current transmission lines, Bull. Assoc. Suisse des Electriciens, Vol. VII, 1916, No. 5, p. 121/134.

68 1914 British Aluminium Co., Pamphlet on Aluminium network feeders, Abst., Iron & Coal Trades Rev., Vol. 89, 1914, p. 203.

69 1913 Anonymous, The use of aluminium for electric cables, Engng., Vol. 95, 1913, p. 812.

70 1913 Aluminum for electrical work, Engng., Vol. 95, p. 812.

71 1913 Pannell, E. V., Value of aluminium line conconductors, Elect. News (Canadian), Nov. 15, 1913, pp. 46/47.

72 1910 Hobart, H. M., Bare aluminium cables, Electr. Times, Vol. 37, Apr. 14, 1910, p. 356.

73 1910 Aluminium lightning arresters for underground cables, Journ. Elect. Power and Gas, Aug. 27, 1910.

74 1909 Buono, V. del, Use of aluminium as electrical conductor, Atti. Assoc. Ellottroteen, Ital., Vol. 13, 1909, pp. 261/289.

75 1904 Krull, F., Application of aluminium wire for electrical transmission, Z. anorg. Chem., Vol. 17, 1904, pp. 1058/60.

76 1903 Stillwell, Use of aluminium for electrical power transmission in the United States, Z. Ver. dt. Ing., Vol. 47, 1903, pp 1826/28.

77 1903 Kershaw, The use of aluminium as an electrical conductor, Electr. Rev. (N. Y.), Vol. 43, 1903, pp. 470/1.

78 1900 Guillaume, Use of aluminium for electrical conductors, Eclairage Electrique, Vol. 22, 1900, pp. 321/8.

79 1900 Perrine & Baum, The use of aluminium line wire and some constants for transmission lines, Trans. Amer. Inst. Electr. Engrs., Vol. 17, 1900, pp. 391/423.

80 1898 Wilson, E., Aluminium as an electrode in cells for direct and alternating currents (Al rectifier cells), Proc. Roy. Soc., Vol. 63, 1898, pp. 329/47.

81 1898 Hunt, Aluminium as a rival of copper and brass for electrical conductors, Engineer, Vol. 86, 1898, p. 81, Iron & Coal Trades Rev., Vol. 56, 1898, pp. 339/50.

VESSELS

82 1914 Anonymous, Aluminium and aluminium wares, Board of Trade Bull. No. 77, 1914, London.

83 1912 Wild, J., Aluminium Gärgefässe, Z. ges. Brauw., Vol. 35, 1912, pp. 61/65; Chem. Z. Bl. 1912, I, p. 1080.

84 1912 Bleisch, C., Aluminium fermentation and storage vats, Zeits. ges. Brauwesen, Vol. 35, 1912, pp. 49/53.

85 1911 Chapman, A. C., Investigation of aluminium with reference to its suitability for the construction of brewery plant, Jour. Inst. Bres., Vol. 17, 1911, pp. 660/678.

86 1905 Schoenfeld, F., Use of aluminium for beer-filters, Wochensohr. f. Brauerei, Vol. 22, 1905, pp. 79/80.

87 1897 Norton, T. H., The use of aluminium condensers, J. Amer. Chem. Soc., Vol. 19, 1897, pp. 153/56.

DEOXIDATION

88 1915 Aluminium as a check to sulphide segregation in steel ingots, Iron Age, Vol. 96, July 15, 1915, p. 130.

89 1915 Talbot, B., Use of aluminium to reduce segregation in steel ingots, Engng. News, 54, 1905, p. 443.

ALUMINOTHERMY

90 1913 Hart, R. N., Welding, The Maple Press, New York City.

91 1909 Weston, F. E. and Ellis, H. R., Heats of combustion of aluminum, calcium and magnesium, Faraday Soc. Trans.; Abst. J. Soc. Chem. Ind., Vol. 28, No. 2, p. 94.

92 1902 Bertin, H., Heating by aluminium and its applications, Mem. de la Soc. des Ing. Civils de France, 1902, pp. 218/249.

93 1900 Matignon, C., Metallurgy founded on reduction with aluminium and the production of high temperatures, Moniteur Scientifique, June, 1900, pp. 353/366.

94 1898 Goldschmidt, New process for producing metals and alloys by means of aluminium powder, Liebig's Annalen de. Chemie, Vol. 301, pp. 19/28.

95 1898 Goldschmidt, H. and Vautin, Claude, Aluminium as a heating and reducing agent, J. Soc. Chem. Ind., Vol. 17, pp. 543/45; Discussion, same Journal, pp. 649/50.

METALLOGRAPHY

96 1918 Anderson, R. J., Metallography of aluminum, Met. & Chem. Engng., 1918, p. 172, Feb. 15th.

TRANSFORMATION

97 1914 Cohen, Allotrophy of metals, Proc. Roy. Akad. of Sciences (Amsterdam), 1914, Vol. 17, p. 200.

98 1914 Laschtschenko, P. N., Specific heat of aluminium; Journ. Russ. Phys. Chem. Soc., Vol. (X) 56, p. 311.

CHEMICAL PROPERTIES

99 1917 Seligman, R., Williams, P., Action of acids on aluminum, Journ. Soc. Chem. Ind., Vol. 36, p. 409.

100 1917 Seligman, R., Williams, P., Action of acetic acid on aluminum, Journ. Soc. Chem. Ind., April 30, 1917; Journ. Soc. Chem. Ind., 1916, pp. 35/88; Met. & Chem. Engng. (abst.), 1917, July, p. 38.

101 1916 Briner, Songlet, The carbides of aluminum, nickel and copper, Rev. Met., p. 155.

102 1916 Seligman-Williams, Action of HnO_3 on aluminum; Journ. Soc. Chem. Ind., Vol. 35, p. 665.

103 1913 Bamberger, M. and V., Jueptner, H., Explosion of aluminium when granulating, Z. anorg. Chem., Vol. 26, pp. 353/55.

104 1913 Matignon, C., Reduction of magnesium by aluminium, C. R., Vol. 156, pp. 1157/59.

105 1913 Kohn-Abrest, E., Application of activated (amalgamated) aluminium for the precipitation of tannin, Bull. Assoc. Chim. Sucr., Vol. 30, 1913, pp. 862/68.

106 1912 Nicolardot, P., Action of salts of mercury and mercury upon aluminium—application to the analysis of aluminium, Bull. Soc. Chim., Vol. 11, 1912, pp. 410/413.

107 1911 Kohn-Abrest, E., Some new applications of amalgamated aluminium and its use in analysis, Bull. Assoc. Chin. Sucr., Vol. 28, 1911, pp. 938/943.

108 1910 Kohn-Abrest, E., Action of heat on aluminium in vacuo in presence of carbon, Bull. Soc. Chim., Vol. 7, 1910, pp. 277/83.

109 1908 Matignon, C., Preparation of aluminium carbide, Bull. Soc. Chem., Vol. 3, 1908, pp. 355/361.

110 1905 Watts, O. P., Use of aluminium as a reducing agent, Amer. Electrochem. Soc. Trans., 1905, Abst., J. Soc. Chem. Ind., Vol. 24, 1905, p. 1116.

111 1905 Kohn-Abrest, Oxidation of aluminium powder, C. R., Vol. 141, 1905, pp. 323/24.

112 1904 Kohn-Abrest, E., Aluminium powder and the oxidation of aluminium, Bull. Soc. Chem., Vol. 31, 1904, pp. 232/39.

113 1902 Alt, M., Discharging paranitraniline red with aluminium powder, Meeting Soc. Ind. Mulhouse, 1902, March 14; Abst., J. Soc. Chem. Ind., Vol. 21, 1902, p. 546.

114 1901 Duboin, A., Reducing properties of magnesium and aluminium, C. R., Vol. 132, 1901, No. 13, pp. 826/28.

115 1900 Matignon, C., Certain properties of aluminium and the preparation of phosphine, C. R., Vol. 130, 1900, No. 21, pp. 1391/94.

CORROSION

116 1915 Aluminium: Its origin and susceptibility, The Metal Industry, Vol. 13, March, 1915, No. 3, pp. 105/06.

117 1914 Pikos, P., Destruction of aluminium apparatus by the galvane-catalytic action of copper; Z. anorg. Chem., Vol. 27, 1914, p. 152.

118 1913 Scala, R., Action of distilled water on impure aluminium, Atti. R. Acad. dei Lincei, Roma, Vol. 22, 1913/I, pp. 43/37, 95/102; Abst., J. Soc. Chem. Ind., Vol. 32, 1913, No. 7, p. 368.

119 1913 Droste, Action of 3% hydrogen peroxide on aluminium, Chem. Ztg., Vol. 37, 1913, p. 1317.

120 1913 Mohr, O., Gefährdung von aluminiumgefässen durch quecksilber, Brau. W. Schr., Vol. 30, 1913, pp. 309/310; Chem. Z. Bl. (5) Vol. 17, 1913/II, p. 320.

122 1913 Bailey, The corrosion of aluminum; Journ. Inst. Met., 1913/I, Vol. 9, pp. 79/109; Abst., Journ. Soc. Chem. Ind., Vol. 32, 1913, No. 6, p. 293.

123 1913 Guillet, L., The influence of "drawing" on the properties of metallurgical products, Rev. Metallurgie, Vol. 10, 1913, pp. 769/777.

124 1912 Schoenfeld, F., and Himmelfarb, G., Behavior of aluminium towards water and air, Wochers. fuer Brau, Vol. 29, 1912, pp. 409/411.

125 1912 Kohn-Abrest, E., Action of water on aluminium "activated" by mercury, Bull. Soc. Chim., Vol. 11, 1912, pp. 570/576.

126 1912 Bleisch, C., Zur Frage der aluminium Gär und Lagergefässe, Z. Ges. Brauw., Vol. 35, 1912, pp. 49/53; Chem. Z. Bl., 1912/I, p. 1060.

127 1912 Strunk, H., Ursache von Flechenbildung auf geschwärtztem aluminium kochgeschiff, Verh. a. d. Gebiete des Militär-Sanitätswesen 1912 Heft 52, Chem. Z. Bl. 1912, p. 1937.

128 1912 Nicolardot, Action of Hg salts on aluminum; Bull. Soc. Chim., Vol. 11, p. 410.

129 1912 Barillé, A., Action of seltzer water on aluminium, Jour. de Pharmacie et de Chimie, Vol. 6/VII, 1912, p. 110.

130 1911 Heyn, E., and Bauer, O., Corrosion of aluminium and aluminium ware, Mitt. Kgl. Materialprufungsamtes, Vol. 29, 1911, pp. 2/28.

131 1909 Kohn-Abrest, E., Action of hydrochloric acid gas on aluminium, and quantitative analysis of metallic aluminium, Bull. Soc. Chim., Vol. 5, 1909, pp. 768/775.

132 1908 Fillinger, V. A., Behavior of aluminium when in contact with milk, wine and some saline solutions, Z. Unters. Nahr.-u. Genussmittel, Vol. 16, 1908, pp. 232/34.

133 1907 Van Deventer, C. M., So-called "passivity" of aluminium towards nitric acid, Chem. Weekblad, Vol. 4, 1907, pp. 69/72; Chem. Zentrabl., 1907/I, p. 1017.

134 1904 Mott, W. R., Protection of aluminium against corrosion, Electrochem. Ind., Vol. 2, 1904, pp. 129/130.

135 1906 Sabin, Technology of paint and varnish.

136 1904 Smith, W., Action of certain solutions upon aluminium and zinc, Journ. Soc. Chem. Ind., Vol. 23, pp. 475/77.

ALTERABILITY

137 1913 Cohn, L. M., Anderung der Eigenschaften von Aluminium, Elektrotech. u. Maschinenbau, Vol. 31, p. 430; Elektr. Masch, 1913, pp. 430/433.

138 1913 Wilson, E., Exposure tests of copper, aluminium and duralumin, Engng., Vol. 96, p. 387.

139 1912 Goldberg, G., Disintegration of aluminium articles, Giesserei Ztg., Vol. 9, p. 534.

140 1911 LeChatelier, H., Alterability of aluminium, C. R., Vol. 152, pp. 650/52.

141 1910 Law, E. F., The failure of the light engineering alloys, particularly the aluminium alloys, Trans. Far. Soc. 6, 1910, pp. 185/198.

142 1892 Winkler, C., On the durability of aluminium; Z. anorg. Chemie, 1892, p. 69.

PHYSICAL PROPERTIES

143 1913 Brislee, F. J., Density of aluminium, Trans. Far. Soc., May 7, 1913, p. 162; Abst., Journ. Soc. Chem. Ind., Vol. 32, p. 539.

144 1912 Brislee, Density and Coefficient of expansion of aluminium, Trans. Far. Soc., Vol. 7, pp. 221/228.

145 1907 Schnurpfeil, The properties of aluminium, its manufacture and alloys, Giesserei Ztg., Vol. 4, pp. 558/59.

146 1903 Burgess, C. F., and Hambuechen, C., Some laboratory observations on aluminium, Electrochem, Ind. (Philadelphia), 1903, pp. 165/68; Abst., Journ. Soc. Chem. Ind., Vol. 22, p. 1135.

147 1902 Granger, A., The pastry state of aluminium below its melting point and the utilization of this property in subdividing the metal, Bull. Soc. Chem., Vol. 27, p. 789.

148 1890 Hunt, E. A., Langley, J. W., and Hall, C. M., Properties of aluminium, Engng. & Min. Journ., Vol. 49, pp. 284/85, 314/16, 334/36; Trans. Amer. Inst. Min. Engrs., Vol. 18, p. 528.

ELECTRICAL CONDUCTIVITY

149 1914 Bureau of Standards, Copper Wire Tables, Circular No. 31, p. 13.

150 1912 Stein, A., Melting point and electrical resistance, Phys. Z., Vol. 13, p. 287.

151 1910 Wolff, F. A., and Dellinger, J. H., The electrical conductivity of commercial copper, Bureau of Standards Sci., Paper No. 148, Vol. 7.

152 1901 Kershaw, J. B. C., Aluminium as an electric conductor, with new observations upon the durability of aluminium and other metals under atmospheric exposure, Inst. Electr. Engrs., 1901, Electrician, Vol. 46, 1901, No. 13, pp. 464/66.

153 1900 Jaeger, W., and Dieselhorst, H., Physikalisch-Technischen Wiss. Abhl. P. T. R., Vol. 3, p. 269.

154 1898 Northrup, Conductivity of aluminium, Elec. World, Vol. 32, 1898, p. 598; Abst., Eclair. Electrique, Vol. 17, 1898, p. 576.

155 1897 Richards, J. W., and Thomson, J. A., Recent determinations of electrical conductivity of aluminium; Journ. Franklin Inst., Vol. 143, 1897, pp. 195/99.

THERMO-ELECTROMOTIVE FORCE

156 1917 Northrup, E. F., Resistivity and thermal E. M. F., Met. & Chem. Engng., Vol. 15, pp. 193/7.

157 1908 Wagner, E., A. T. E. F., Aun. d. Phys., Vol. (4) 27, p. 955.

158 1900 Jaeger, W., and Dieselhorst, H., T. E. F., Wiss. Abh., Vol. 3, p. 269.

159 1895 Dewar and Fleming, T. E. F., Phil. Mag., Vol. (5) 40, p. 95.

ELECTROLYTIC SOLUTION POTENTIAL

160 1894 Neumann, B., Uber das potential des Wasserstoffs und einiger metalle, Z. Phys. Chem., Vol. 14, p. 193.

MAGNETIC CHARACTERISTICS

161 1910 Honda, K., Mag. Thermomagnetische Eigenschaften den Elemente, Aun d. Phys., Vol. (4) 32, p. 1027.

162 1905 Wills, A. P., Mag., Phys. Rev., Vol. 20, 1905, p. 188.

CHANGES OF STATE

163 1915 Bureau of Standards, Melting points of chemical elements, Circular No. 35.

164 1909 Greenwood, B. P., Proc. Roy. Soc. Vol. 82, p. 396.

165 1908 Wartenberg, H., B. P., Z. anorg. Chem., Vol. 56, p. 320.

THERMAL CONDUCTIVITY

166 1908 Lees, C. H., Thermal and electrical conductivity of metals and alloys at low temperatures, Phil. Trans., pp. 208, 381.

167 1900 Jaeger, W., and Dieselhort, H., Wiss. Abhandl. P. T. R., pp. 3, 269.

THERMAL EXPANSION

168 1913 Chamberlain, J. H., A study of the volume change in alloys, Journ. Inst. Metals, 1913/2, Vol. X, p. 193.

169 1911 Brislee, F. J., Determination of density and coefficient of linear expansion of aluminium, Trans. Far. Soc., June, 1911, Vol. 7, p. 221; Abst., Journ. Soc. Chem. Ind., Vol. 31, 1912, No. 1, p. 30.

170 1910 Ewen, D., and Turner, T., Shrinkage of and the Al-Zn alloys during and after solidification, Journ. Inst. Metals IV, p. 128.

171 1909 Turner, T., and Murray, M., The volume change in Cu-Zn alloys, Journ. Inst. Metals, Vol. 2, p. 98.

172 1907 Henning, F., Aun d. Phys., Vol. (4) 22, p. 631.

173 1902 Dittenberger, W., Uber die Ausdehning von Eisen, Kupfer, Aluminium, messing und bronze in hoher Temperatur, Z. Ver. deutsch Ing., Vol. 46, p. 1532.

SPECIFIC HEAT

174 1916 Brislee, F. J., The specific heat of hard and soft aluminium, Paper read at the meeting of the Faraday Society (Paper II), Trans. Far. Soc., Vol. 12, p. 57.

175 1904 Glaser, Schinelzwärmen-und specifische wärme bestimmingen von metallen bei höheren temperaturen, Metallurgie, Vol. 1, pp. 103, 121.

176 1903 Tilden, atomic and specific heats, Proc. Roy. Soc., Vol. 71, p. 220.

177 1892 Richards, J. W., The specific heat of aluminium, Journ. Franklin Inst., Vol. 133, 1892, pp. 121/24; Chem. News, Vol. 65, 1892, p. 97; Abst., Chem. Ztg. Report, Vol. 16, 1892, p. 97.

178 1892 Le Verrier, M., Sur la chaleur spécifique des métaux, C. R., Vol. 114, p. 907.

OPTICAL

179 1913 Coblentz, Diffuse reflecting power, Bulletin Bureau of Standards No. 195, Vol. 9, 1913, p. 281.

180 1911 Coblentz, Optical, Bulletin Bureau of Standards, Vol. 7, p. 197.

181 1890 Drude, Ann dei Phys. u. Chem., Vol. 39, p. 481.

ELASTICITY

182 1915 Koch, K. R., and Dannecker, C., Elasticity at high temperatures, Ann. d. Physik (IV), Vol. 47, p. 197.

183 1913 Brislee, F. J., Elastic modulus of aluminium, Trans. Far. Soc., Vol. 9, Nos. 1-2, pp. 155/161.

184 1913 Brislee, Elastic modulus of Aluminium, Trans. Far. Soc., Vol. 9, pp. 155/161.

185 1903 Cardani, P., Direkte Bestimmung der Poissonscheu Beziehung in Drahten, Phys. Z, Vol. 4, p. 449.

186 1903 Angenheister, G., Beiträge zur Kenntniss von der Elastizität der Metalle.

MECHANICAL PROPERTIES

187 Herman A. Holz booklet describing the Ericksen machine.

188 1918 Anderson, R. J., Annealing and recrystallization of cold-rolled alluminium shell, Met. & Chem. Engng., Vol. 18, p. 523.

189 1914 Elmendorf, A., Tables and charts resulting from the testing of cast aluminium on a White-Souther rotary testing machine, Amer. Mac., Vol. 41, 1914, p. 811

190 1913 Stress-strain relations for aluminium wire according to experiments by the British Insulated and Helsby Cable Co., Engng., Vol. 96, p. 197.

191 1913 Wyss, W., Resistance to bending, extension, specific gravity and hardness of cast rods of aluminium, cast iron and bronze, Ferrum, Vol. 10, pp. 167, 184, 207/217.

192 1913 Deinhardt, K., The machining of aluminium and white metals, Machinery, Vol. 19, p. 970.

193 1913 Chamberlain, J. H., A study of volume changes in alloys, Journ. Inst. Metals, Vol. X, p. 193.

194 1909 Smith, A., The elastic breakdown of non-ferrous metals, Journ. Inst. Metals, Vol. 2, pp. 131/231.

195 1906 Morley, A., and Tolinson, G. A., Tensile overstrain and recovery of aluminium, copper and aluminium-bronze, Phil. Mag., Vol. 11, pp. 380/392.

196 1902 Wilson, E., and Garvey, J., Journ. Inst. Elect. Engrs., Vol. 31, p. 154.

EFFECT OF TEMPERATURE ON THE PROPERTIES OF ALUMINIUM

197 1916 Ludwik, P., Change of hardness with temperature, Z. Phys. Chem., Vol. 91, p. 232.

198 1914 Nernst, W., and Schwers, F., Specific heat at low temperatures, Setzimpber. dei. Kgr. Akad. Wiss., Berlin, p. 355.

199 1913 Rosenhain, W., and Ewen, D., Intercrystalline cohesion of metals, Inst. of Metals, Vol. 10; Abst., Journ. Soc. Chem. Ind., Vol. 32, No. 18, p. 914.

200 1912 Bengough, G. D., A study of the properties of alloys at high temperatures, Journ. Inst. Metals, 1912/1, Vol. 7, p. 123.

201 1911 Baumann, R., Tests with welded and nonwelded aluminium at ordinary and at high temperatures, Mitteilungen über Forschungsarbeiten auf dem Gebiete des In Ingenierswesen, 1911, No. 112, pp. 23/40; also in Z. Verein Deutscher Ingenieure, Dec. 2, 1911, p. 2016 et seq.

202 1911 Nernst and Lindemann, Specifische Wärme u Quantentheorie, Z. Elektrochem., Vol. 17, p. 817.

203 1910 Schimpff, H., Uber die Wärmekapagität von Metallen und Metallverbindungen, Z. f. Phys. Chem., Vol. 71, p. 257.

204 1907-8 Breuil, P., Fabrication a fraid des tubes et profites, La Genie Civil, pp. 41, 369; Proc. Inst. Civil Eng., No. II, p. 361.

205 1907 Niccolai, G., The electrical resistance of some metals at higher and lower temperature, Lincei Rend. (5) 16, p. 576, 906; II, 185.

206 1893 Dewar and Fleming, The electrical resistance of metals and alloys, Phil. Mag. (5) 36, p. 271.

EFFECT OF MECHANICAL WORK AND HEAT TREATMENT ON THE PHYSICAL PROPERTIES

207 1917 Carpenter, H. C. H., and Taverner, L., The effect of heat at various temperatures on the rate of softening of cold-rolled aluminium sheet, Journ. Inst. Metals, adv. prints of Fall (1917) meeting, Vol. 18, pp. 115-156, 156-171.

(To Be Continued)

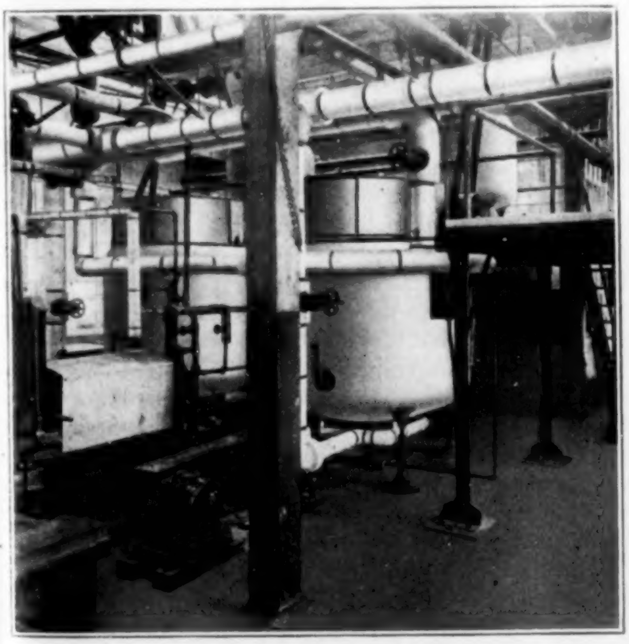
A Practical Oil Circulating System For Indirect Heating

THE rapid advance of the chemical and allied industries during the last decade has created a demand for equipment that was radical in design and which in many instances the market was unable to supply, as the new products and methods of manufacture required apparatus that up to that time had not been produced.

This condition was especially true in regard to the method of supplying heat to the new equipment. The chemists had performed their part, when they determined what ingredients should be used and how to prepare the final compound. It was now up to the engineer to furnish the means of producing it on a large scale.

Many products required high temperature in manufacture with perfect and instantaneous control and uniform heat distribution. Uniformity of treatment of the product was necessary. High pressures were not desirable because apparatus of complicated design and generally with its inner surfaces enamelled could not be economically built to withstand high pressures. Elimination of fire hazards was sought because the materials were organic and often of an inflammable nature. These severe demands had to be met with a heating system that must be thoroughly practical, clean, free from interruption and easily operated by unskilled attendants. Points of no less importance to be considered were low costs of apparatus, insurance rates, repairs and upkeep.

The only available methods of heating were by direct-fire, steam or electricity. Direct-fire could not meet these requirements because of the difficulties in controlling temperature, poor heat distribution and fire menace. Saturated steam did not provide high enough temperature ranges, so attention was turned toward superheated steam. The difficulties encountered with high pressures, heavy and expensive equipment, frequent packing blow-outs and repairs, sudden changes in temperature and its inefficient temperature gradient made superheated steam undesirable, even in the few cases where it could be used. The only other method commercially available was electric resistance heating, but this was not acceptable. The apparatus in most cases could not be readily adapted to this form of heating. First cost of apparatus was high, the fire hazard great and the operating cost exorbitant.



JACKETED MELTING KETTLES AND MEPROLENE LINES

With these rigid specifications in view, engineers naturally turned their attention to something new and decided to try out a high temperature circulating liquid system of which the domestic hot water furnace is a prototype. The problem then resolved itself into finding a suitable liquid material for conveying the heat, one that could be safely heated up to high temperature without chemical change and be free from carbonization and, second, into designing a heater and apparatus for circulating the hot liquid between chemical apparatus and the heater.

A number of attempts were made to build oil circulating systems, but when they were put into operation they were not successful because the type of oil on the market was not suitable for this class of service inasmuch as it coked and clogged the system. It was soon learned that the heat could be designed only after careful study and semi-commercial experimenting. Other difficulties with pumps and leaky pipe lines soon made it appear as though this method could not be practically worked.

The engineers of the G. M. Parks Company of Fitchburg, Mass., anticipating a number of years ago the urgent and surely increasing demand for an oil circulating heating system that would meet the most exacting requirements of the manufacturer, have devoted their entire time to the solution of the many problems that arose in connection with the installation and operation of such a system. The system they have evolved comprises the following elements: The absorber or heater, the circulating equipment, special pipe fittings and the heat conducting oil. These elements are usually connected with any type of apparatus to which the heat to be furnished by them is to be delivered by circulation. The circulating oil is mechanically circulated and passes through a specially constructed heat absorber. Then it is pumped through pipes to the apparatus to be heated—jacketed kettles, stills, tanks, etc. After delivering a certain controlled portion of its heat, the circulating oil returns through the pump to the absorber for re-heating. The entire system is under hydrostatic pressure from an expansion tank open to the atmosphere. The only additional pressure, rarely exceeding 15 pounds, is due to the frictional resistance of the pumped liquid.

The absorber and fuel supply may be located at any reasonable distance from the manufacturing apparatus—completely isolated, if the product is inflammable. All fire risk thus can be avoided. The circulating oil is of the most importance and must have no free-carbon or inflammable distillate at 600 deg. F. Its copyrighted name is "meprolene."

Meprolene has very high flash and fire tests. It withstands high temperatures for indefinite periods. It

does not carbonize, distill or "crack." It is made especially for use in this process.

The absorber is of peculiar design and consists of the heating element, which is built into a brick furnace. It has a dutch oven extension and is strongly reinforced by steel framework. The heating element is made of two-inch boiler tubes expanded into cast headers of heavy design. It is divided into one or more paths of flow to insure current consistent with maximum efficiency and heat transfer. Heavy plugs are screwed in the headers opposite the ends of each tube which permit of easy access to the inside of the tubes for cleaning. Cleanout doors in the furnace walls and insulated steel doors at each end of the absorber are easily removed and expose the entire heating element. Either fuel oil or gas can be used for heating.

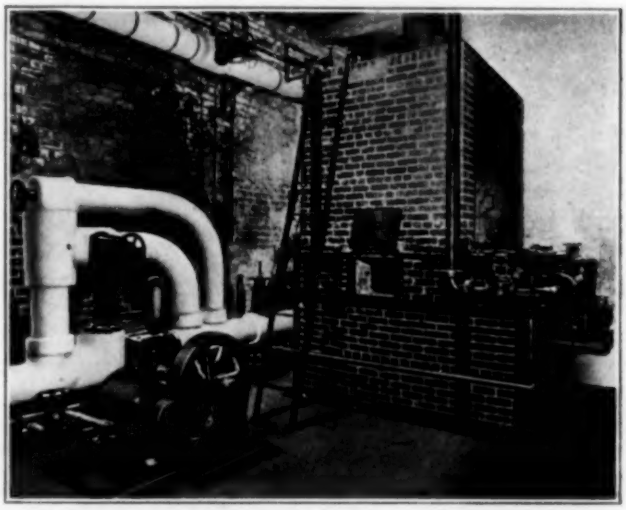
The circulating equipment includes a Kinney positive displacement rotary pump, usually motor driven through silent gearings, the pump and motor being mounted on a unit sub-base.

Pipe mains and all meprolene circulating lines are of standard weight steel pipe and, with the exception of the smaller sizes, have flanged connections. The flanges are made of forged steel and welded to the pipe. The gaskets used on the flanges are made for service in this class of work. Patented automatic valves give thorough protection from damage that might otherwise result from negligence or improper handling. These valves automatically shut off the fuel from the burners if there is any interruption to the flow of the meprolene or of compressed air when air atomizing oil burners are used. Other automatic devices can be attached to shut down the system if it is damaged by an external source.

Two accompanying photographs show a typical installation of the Merrill system of heat transmission, and two melting kettles which are part of a battery of six. At the particular plant where this system is installed, it was intended to use superheated steam for heating these kettles. The equipment was installed with all piping connections, valves, insulation, superheater, etc., but after several months had been spent in an endeavor to use superheated steam, this method was abandoned, as the superheating equipment could not furnish heat enough for even one kettle. The quantity of steam necessary was so great that it was decided to be entirely impracticable, if not impossible, to use it.

The photograph of the system shows a standard absorber with a normal heat output of 800,000 B.t.u. per hour, a circulating pump with a capacity of 160 g.p.m., a 10-hp. motor and all necessary accessories such as gages, thermometers, automatic valves, etc. This machinery is installed in a one-story building outside of the manufacturing plant. The floor space of this building is about 16 x 26 ft. City gas is used for fuel.

The battery of melting kettles is located on the third floor of the manufacturing building. They are approximately 5 ft. in diameter, 5½ ft. deep, open top, glass enamelled and equipped with agitators. The kettles have a jacket space of about three inches around the entire sides and bottom. Meprolene is circulated through four-inch pipe mains coming up from the absorber room. The meprolene enters the jackets at the bottom and exits from the top, returning to the absorber to be reheated. These kettles are used in the manufacture of a compound the ingredients of which are charged into them at room temperature. These materials are fused and heated to 380 deg. F. The weight of a charge is three tons and the material has an average specific heat of 0.74, which includes the latent heat of fusion. After the compound has liquefied, 1700 pounds of water is added and this is raised from 60 to 212 deg. F. and completely evaporated in the process. This work is performed in about three and one-half hours time. The



KINNEY PUMP, ABSORBER AND CONTROL DEVICES

meprolene enters the jackets at 500 deg. F. and returns to the absorber at 475 deg. F. thus having a 25-deg. gradient.

In another manufacturing plant, batches of 3000 pounds of asphalt are being melted. The hot product is used in open pans for saturating purposes.

Three U-shaped jacketed kettles and ten long U-shaped jacketed saturating pans comprise the equipment.

As first installed, steam at 125 pounds pressure was the source of heat. High pressure in the jackets caused strains resulting in constant leaks, and soon the insulation was ruined. The absence of insulation made the room temperature unbearable in summer as well as increasing the fuel cost.

Steam at 125 pounds pressure has a corresponding temperature of 345 deg. F. The mixture required 300 deg. F. The thermic head was but 45 deg. F. With everything working as well as possible, the heat transfer was slow, but frequent delays caused by leaks, bothersome steam traps and reducing valves made production uncertain. The passing of the product to be coated through the saturating pans absorbed the heat so rapidly that frequent stops were necessary to permit the temperature to rise to a workable point again. Even with the highest attainable steam pressures uniformly good quality of product was not obtained.

The identical equipment now operates on a Merrill oil circulating system at 475 deg. F. The pressure is now but 14 pounds. Ample thermic head has assured steady production. Reduced pressure has stopped leaks. New insulation makes the work room more comfortable. The time of melting a batch is now thirteen hours as compared to thirty-two hours required with steam. The production decidedly increased, although there are 35 per cent fewer operatives employed.

Other installations have been made in a number of the leading plants throughout the country, and are used in the manufacture of chemicals, dyes, rubber wire insulation, roofing felt saturation, metal and paper coating and other industries were high constant temperatures and controllable heat are required.

These systems are built in a number of standard sizes. ranging in size from 50,000 to 1,300,000 B.t.u. per hour. Capacities greater than this are taken care of by connecting the absorbers in battery.

Soldier Chemists Back to Industry

When the United States entered the European war one of the first problems to be considered was the effect of the draft upon essential industries. It was early appreciated that in order to maintain full efficiency it would be necessary to conserve as far as possible skilled workers and men with technical training. In order that we might not suffer from the depletion of our ranks, steps were taken to secure deferred classification and later on provision was made to furlough back to industry. This arrangement made it possible for chemical industries to maintain their efficiency and has contributed largely to the effectiveness of our forces in the field.

Up to the time of cessation of hostilities the Industrial Relations Branch of the Chemical Warfare Service had recommended for deferred classification 641 chemists and skilled workers. These recommendations were favorably considered, as a rule, by the Local Boards, and as a result about 90 per cent of the men so recommended were put in a deferred class. Many cases, however, were not brought to the attention of this branch until the men had actually been called into service. Such chemists or skilled workers as were essential to industry were then furloughed in order that the production of war materials might not be retarded. Through this method 156 men had been returned to industry, and at the time of the signing of the armistice 120 more cases were pending in the Adjutant General's Office.

As hostilities cease we naturally must again turn to peace-time conditions and look forward to the future development of chemical industry in America. The problem now before the Industrial Relations Branch of the Chemical Warfare Service is to assist chemists in service to secure positions where their training and experience can be used to the best interests of the Government. This enormous readjustment is rendered possible through the information gathered by Dr. Charles L. Parsons, secretary of the American Chemical Society, and through the questionnaires sent out by Major F. E. Breithut of the Personnel Division of the Chemical Warfare Service.

In order to accomplish results the chemists now in military service who desire to return to chemical industry are being requested to inform the chief of the Industrial Relations Branch concerning their future prospects, while the manufacturers are being asked to designate their requirements for chemists. The administration of this work will be carried out by the Industrial Relations Branch so that any information desired may be obtained by writing to Major Allen Rogers, Chief, Industrial Relations Branch, Chemical Warfare Service, 7th and B Streets, N. W., Washington, D. C.

Société de Chimie Industrielle

Secretary Charles A. Doremus announces that a meeting of the New York Section of the Société de Chimie Industrielle will be held in Rumford Hall, 50 East 41st Street, on Tuesday evening, Nov. 19, beginning promptly at 8.30 o'clock.

The program for the evening will be: "Industrial Efforts in France During the War," Georges Maoussa, Docteur ès Sciences, member of the French High Commission; "The Electrochemical Industries in France," C. O. Mailloux, E.E., M.S., D.Sc., past president of the American Institute of Electrical Engineers; member of the American Industrial Committee to France; General Discussion of Ways and Means for Insuring the Further Development of the Société de Chimie Industrielle.

$100 Reward

A reward of $100 is offered for the recovery of the platinum dishes and crucibles answering the following descriptions stolen from the Kentucky Agricultural Experiment Station, Lexington, Ky., during the week following Oct. 17, 1918, or for information leading to the conviction of the thief:

Platinum crucibles—No. 2, weighing 11.9750 grams, No. 3, 11.9703 grams, No. 10, 16.0273 grams, No. 13, 8.4319 grams, No. 18, 15.8232 grams, No. 22, 15.7905 grams, No. 26, 15.7580 grams, one not numbered, 18.-9431 grams. Platinum dishes—No. 1, weighing 46.4689 grams, No. 11, 32.6709 grams, No. 12, 33.0927 grams, No. 14, 49.1097 grams, No. 15, 48.6788 grams, No. 20, 48.5347 grams, No. 22, 48.3856 grams, No. 23, 47.2223 grams.

Personal

DR. ARTHUR L. DAY has presented his resignation as director of the Geophysical Laboratory, Carnegie Institution of Washington, effective Oct. 1, 1918, and will take up research on glass and allied materials for the Corning Glass Works in Corning, N. Y. Dr. Day has been director of the laboratory since its establishment in 1906, having been previously engaged in silicate researches at the U. S. Geological Survey in 1904 and 1905.

MR. F. N. FLYNN has resigned as general superintendent of the smelting and refining departments of the Consolidated Mining & Smelting Co. of Canada, Ltd., at Trail, B. C.

MR. L. H. GOEBEL is now associated with the engineering staff of Wallace & Tiernan Co., manufacturers of chlorine control apparatus and sanitary engineering specialties. He was formerly superintendent of filtration and chief chemist of the Water Filtration Plant of the Union Stock Yard & Transit Co., Chicago, Ill.

DR. ALCAN HIRSCH, chemical engineer of New York City, recently married Miss Edith D. Borg.

MR. DORSEY A. LYON of the U. S. Bureau of Mines has been placed in charge of the Pittsburgh Station as well as the other ten experimental stations of the Bureau. His headquarters will be in Pittsburgh.

MR. NATHAN OWITZ, for the past four years general manager of the J. P. Devine Co., Buffalo, N. Y., has resigned to accept the presidency and management of the Persol Chemical Corp., which he recently organized.

MR. CHARLES D. TEST, formerly chemist for the Western Potash Works of Antioch, Neb., has accepted a position on the staff of the United States Tariff Commission.

MR. B. H. TRIPP has been appointed district manager of sales for the Pacific Coast territory of the Chicago Pneumatic Tool Co. of Massachusetts. His office will be in San Francisco, Cal.

MR. WILLIS WERNER has been appointed chief chemist of the Republic Iron & Steel Co., Youngstown, Ohio. He will have charge of the blast furnace and open-hearth laboratories.

MR. F. W. BRUCKMILLER is now chemist for the Standard Oil Co. (Indiana), at Sugar Creek, Mo. He was formerly assistant professor of chemistry at the University of Kansas.

MR. ARTURO R. CALVO, for the past five years manager of sales of the Permutit Co., has resigned to become an officer and director of the Hercules Engineering Corporation and its affiliated interests, the Electrolytic Engineering Corporation and the Technical Products Co.

MR. FRANK D. CARNEY, chief metallurgist, and LEWIS B. LINDEMUTH, superintendent of the crucible and electric furnace departments of the Bethlehem Steel Co., Bethlehem, Pa., resigned their positions on Nov. 1 and have formed the partnership of Carney & Lindemuth, consulting engineers in iron and steel metallurgy and practical steel works operation, with offices at 40 Wall St., New York City.

MR. BENTON DALES is now research chemist for the B. F. Goodrich Co., Akron, Ohio, having formerly been head of the chemistry department of the University of Nebraska.

MR. ANDREW M. FAIRLIE, consulting chemical engineer, announces the opening of an office for general consulting practice at 1204 Third National Bank Building, Atlanta, Ga. Mr. Fairlie, who has been for several years chemical engineer for the Tennessee Copper Co., is still retained by that company in a consulting capacity.

PROFESSOR H. F. MOORE of the Engineering Experiment Station of the University of Illinois, Urbana, Ill., has been appointed, by the National Research Council, chairman of the committee to investigate the fatigue phenomena of metals.

MR. WILLIAM E. PULIS and MR. NATHAN M. CLARK have been elected vice-presidents of the Celluloid Co., 36 Washington Place, New York.

MR. RUSH T. SILL of the firm of Sill & Sill, consulting mining and metallurgical engineers, has received a commission as Captain of Engineers and is reporting at Fort Douglas.

MR. F. E. SMITH has accepted the position as chief engineer with the Barber-Greene Co., Aurora, Ill. Mr. Smith was formerly of the engineering department of the Stephens-Adamson Mfg. Co. and of the American Zinc & Chemical Co.

MR. R. H. WILSON has been appointed by the Walter A. Zelnicker Supply Co. as assistant to the president with an office at St. Louis. Mr. Wilson has been with the company for some time, latterly as Houston representative.

Obituary

MR. WINTHROP R. CADY, sales manager of the Colorado Iron Works Co., died in Salt Lake City on Friday, Oct. 25, of pneumonia, following influenza at the age of 31. Mr. Cady had a record of seventeen years' continuous service with the Colorado Iron Works Co., and had a wide acquaintance among metallurgists and mining men of the West.

LIEUT.-COL. HARRISON, controller of the chemical warfare division of Great Britain, died of pneumonia Nov. 6. Lieut.-Col. Harrison took a leading part in the development of protective apparatus against gas attacks.

PROFESSOR WILLIAM MAIN, scientist and engineer, and formerly professor of chemistry in the University of South Carolina, died recently at his home in Piermont, N. Y., in his 74th year. He established the first assay office in the State of Colorado in 1866 and was one of the pioneers of the copper and lead mining industries of this country, having developed and introduced machinery and methods which are still in use in these industries. He was the inventor of the lead-zinc storage battery, and the first to commercially apply the storage battery to the propulsion of street cars. For many years he had resided in or near New York City, engaging in the profession of consulting chemist, and had also been widely employed as an expert in cases before the courts, involving complicated scientific and engineering questions. A veteran artillerist of the Civil War, he had devoted his attention, since the entry of the United States into the present war, to the problem of accurate sighting of anti-submarine guns carried by aëroplanes and to chemical problems vital to the interests of our country in the war. He was a charter member of the American Society of Mechanical Engineers and of the American Electrochemical Society and a member of the American Chemical Society, the Society of Chemical Industry of Great Britain and various other scientific and literary bodies.

Current Market Reports

The Non-Ferrous Metal Market

Thursday, Nov. 7.—The non-ferrous metal market is likely not to alter immediately from its steady course at any single period during the prospective transition from a war basis to regular industrial pursuits. Antimony alone is declining, because the producers are forcing the market slightly to consume their offerings.

Aluminium:—The Government prices on ingots 98 to 99 per cent Al are \$660 a ton f.o.b. plant in 50-ton lots; \$662 down to 15-ton lots; and \$666 down to 1-ton lots, which prices will continue the remainder of the year. Prices per pound for small lots vary from 40c. to 45c.; sheet aluminium, 18 ga. and heavier, 42c.; powdered aluminium, 100 mesh, 70c.

Antimony:—Antimony continues to decline, not having a strong demand. Prices are between 9c. and 9½c. per pound.

Chrome:—Western production is now in slight excess of demand. The nominal quotation for 40 per cent ore is \$1.40 per unit, while 50 per cent ore is bringing \$1.70.

Copper:—The price of \$520 per ton for carload lots and 27.3c. per pound for small quantities was continued for another period at the conference held on Oct. 25 at Washington.

Copper sheets, hot rolled	lb.	\$0.36 —\$0.37½
Copper sheets, cold rolled	lb.	.37 — .38½
Copper bottoms	lb.	.44 — .45½
Copper rods	lb.	.36 — .37
Copper wire	lb.	.29½— ....
High brass wire	lb.	.28¾— .29¾
High brass sheets	lb.	.28¾— .29¾
High brass rods	lb.	.26¾— .28¾
Low brass wire	lb.	.32½— .34½
Low brass sheets	lb.	.32½— .34½
Low brass rods	lb.	.33½— .35½
Brazed brass tubing	lb.	.37 — .39
Brazed bronze tubing	lb.	.42½— .44½
Seamless copper tubing	lb.	.41 — .43
Seamless bronze tubing	lb.	.45 — .46
Seamless brass tubing	lb.	.37½— .39½
Bronze (gold) powder	lb.	1.00 — 1.75

Lead:—The lead market is limited by selling restrictions, the supply being allocated by the Lead Committee. In carload lots at East St. Louis, the price is \$155 per ton. In New York all speculative and traders' lead has disappeared. The Lead Committee apportions lead at 8.05c. to legitimate consumers.

Manganese:—The scale prices on page 629 of CHEMICAL & METALLURGICAL ENGINEERING, June 15, prevail; the highest price per unit being \$1.35.

Silver:—Due to the flow of silver to Asia in payment for munitions and the greatly increasing industrial consumption in photography, motion picture reels and silverware, there is a shortage of silver even at the present Government price of \$1.01½ per ounce.

Tin:—The Tin Committee of the American Iron and Steel Institute has not yet announced the official price on tin. No doubt an understanding will have to be had with the producers before a final statement can be made public and as they are all in distant foreign countries, considerable

time will elapse in intercommunication. During November 3575 tons entered our Pacific ports and 685 tons entered our Atlantic ports. The price is around 78c. lb., but there are no open transactions.

Tungsten:—The Western producers of scheelite are reluctant in offering at $26 per unit. High grade wolframite is bringing $25. Off-grade ores vary from $20 to $24.

Zinc:—Spelter is tending to decline slightly. East St. Louis is quoting $173 per ton for spot, November delivery, $174, December $179, and January $166. Zinc dust, 13¾ to 16c. per lb. Sheet zinc, 15c. per lb.

OTHER METALS

Bismuth	lb.	$3.50 —$3.65
Cadmium	lb.	1.50 — ...
Cobalt	lb.	2.50 — 3.50
Magnesium	lb.	1.75 — 2.10
Mercury .75	lb.	125.00 — ...
Mercury	lb.	1.95 — ...
Nickel	lb.	.40 — .43
Tungsten	lb.	34.00 — ...
Iridium	oz.	175.00 — ...
Paliadium	oz.	135.00 — ...
Platinum	oz.	105.00 — ...

The Iron and Steel Market

The absorbing question before the iron and steel trade is the course of events in the market during the transitionary period from war-time to peace-time conditions. For the longer future, the almost unanimous opinion is there will be heavy demand for iron and steel and at quite remunerative prices, but there must of necessity be a transitionary period while the market finds itself or has the level found for it. Steel, in the final analysis, is used chiefly for construction purposes, money being invested in expectation of returns over a period of years. Some buyers of steel are justified simply in paying the current market price from week to week or month to month, but investment buying cannot proceed on that policy. There may be such a market decline in construction costs in three months as would equal the return on investment for several years, hence the investment buyer of steel must await settled conditions.

While the authorities at Washington have given to the press some intimations that cancellations of war contracts will be more or less gradual, it goes without saying that as to many items of war steel it would be a woeful waste of money to allow manufacture to continue a day longer than really necessary in the interest of maintaining conditions during the discussion and settlement of peace questions. There has been a tremendous production of shell steel and likewise a tremendous consumption of shells. When the consumption ceases the production should cease, because even at that the material in transit and in course of manufacture represents a very large stock of shells.

The authorities have made it clear to holders of large contracts that may be cancelled that the contractors will be treated fairly and that they will suffer no actual loss. The plan worked out, although not publicly announced, is that all material completed will be accepted and paid for, and all material in course will be purchased at a valuation including a pro rata of profit against the total profit that would accrue on the completed material. Material in course will be interpreted to include not only material in actual process of manufacture, but material definitely acquired for the purpose of filling the contract. Having purchased such material, the Government will sell it in the best market, in most cases doubtless to the contractor himself.

Control in Transitionary Period

Several weeks ago it was plainly intimated that the War Industries Board desired to continue its regulation of industry after the termination of hostilities, for the purpose of protecting industry from violent reaction and establishing a permanent basis upon which industry could go ahead for the years of work that are to follow the war. Since then there has been active work on plans looking to the continuance of activity of various Government agencies for a period, perhaps six months, after the President's peace proclamation. The War Industries Board and the Food and Fuel Administrations would terminate upon the official declaration of peace. The Railroad Administration is legally empowered to continue for 21 months thereafter, while the Shipping Board continues indefinitely, and its present program, which it has announced lately is not to be altered, covers 15,000,000 tons deadweight of vessels, of which about 2,500,000 tons has thus far been built. A committee has been established to formulate a plan for the continuance of various control activities, and it is practically stated that such legislation as appears desirable will be sought from Congress. Apart from extension of the time limit of these activities, it is important that the relationship between the contemplated activities of the War Industries Board and the Sherman law should be established. As to iron and steel, the board has agreed with the producers upon certain maximum price limits, which could not be interpreted as in violation of the Sherman law, even if it had not been laid on the shelf or had something else done with it for the period of the emergency. The great majority of the trade, however, feels that what is to be needed for the next few months at least is the fixing of minimum prices, and if the board agrees with the producers on minimum prices, that constitutes an agreement also among the producers themselves, possibly quite another matter in the eyes of the Sherman law.

While there have been some clear evidences that some steel can be sold for export at prices above the Government limits, and it appears even that some such export orders have been booked, it is practically the unanimous opinion that if left to itself the domestic market in iron and steel would in no great while suffer a very severe slump while buyers were waiting for a stable market to be established. The familiar course, as exemplified over and over again in steel market history, is for prices to drop very sharply and to a level much below that which is subsequently established as a safe trading basis for all concerned. On the whole such disorganization is very undesirable, and it is undesirable to the Government, which expects to collect heavy taxes. There is a small minority in the trade that would probably welcome a slump, in expectation of its affording means for general reductions in cost of production, including reductions in wages. A couple of years ago such a view was indeed the common one, but meanwhile evidence has accumulated that a universal and heavy decline in wages and commodity prices cannot be expected, hence there has lately been very much less desire for a "shake-out" after the war than there was some time ago.

Direct Government Influence

That the Government will directly have great powers to exercise an influence upon steel prices is obvious, on account of the large purchases to be made for a long time to come by the Shipping Board and the Railroad Administration. It has lately become quite clear that the Government fully intends to exercise its power, that no purchases will be made that could afterward be called in question as representing an unwise use of public funds. For instance, the Railroad Administration has refused to approve the prices of $55 and $57 for bessemer and open-hearth rails agreed upon last September between the War Industries Board and the rail makers, and points out that the average price on rails bought by the roads long ago and still undelivered is about $36. A dozen or more railroads protested against being required to accept freight cars allotted them from the 100,000 cars ordered by the Railroad Administration, asserting that the cars should be bought from the revolving fund and afterward sold to the railroads at something like peace-time prices. These protests have been overruled by the Railroad Administration, but subsequent purchases, which undoubtedly must be made, will naturally be at as low prices as can be compassed. Again, the Shipping Board has decided, although official announcement does not seem to have been made, to cut down the weekly plate allotment of 50,000 net tons for account of the Fleet Corporation to an amount not exceeding the actual flow of plates into hulls. A surplus of about a million tons has accumulated, representing a factor of safety when every possible ship counted, no matter what the expense, but too expensive to maintain for peace times. The 50,000

tons a week is equal to about 700,000 tons deadweight of vessels per month, while the actual rate of construction has averaged between 300,000 and 400,000 tons a month for several months past. The Director General of Shipbuilding has lately stated that 700,000 tons a month is the objective and that it is expected to be attained next spring. In the interim the plate quota will be reduced, by perhaps between 30 and 50 per cent, and the million-ton surplus may also be reduced, so that 50,000 tons a week of plates may not be called for again altogether as soon as vessel construction reaches 700,000 tons deadweight a month.

Thus the Railroad Administration and the Shipping Board will be able to exert a powerful influence toward a general reduction in steel prices, while on the other hand, when these Government instrumentalities purchase for peace times steel at certain prices, those prices will have considerable standing with the trade at large; and with the influence of the War Industries Board, together with such additional powers as may be granted it, there is opportunity promised for a safe and reasonable readjustment in iron and steel prices.

The Chemical Market

HEAVY CHEMICALS:—The past two weeks have shown considerable lack of activity, with few transactions of note, other than the usual trading that is in evidence. Medicinal products were in strong demand and in most instances prices have had an upward tendency, while some of the other products that come under this heading were shaded in prices. One of these was caustic soda, which has developed a rather weak position, in view of the lack of buying interest, while its allied product, soda ash, has been more firm, although conditions relative to this material in the West and Middle West have not been so favorable.

Bichromate of Soda:—There has been continued inactivity in this market and the position of the item is apparently gaining no strength. In spite of the frequent cheap offerings that appear on the market there is a very noticable lack of interest. At the close sòme sales were made at 19½c. for the standard brands, and most factors are now quoting at that figure.

Soda Ash:—A rather firm situation prevails in the East for this item where bag material is in strong demand, but barrels are more or less neglected, particularly so in the West and Middle West, where prices have been on the decline during the latter part of the past two weeks. Single bag material in New York was generally quoted at from $2.65 to $2.70, while in Chicago offerings were made at $2.60. Double bags in the Middle West were held at $3, while barrel material was offered at $2.85, though in New York prices ranged from $3.10 to $3.15.

Bleaching Powder:—While stocks of this material are none too free for civilian consumption, the persistent demand that has been in evidence for a long period has eased up considerably during the latter part of the past two weeks. Some sales were consummated at 7c., though offerings at the close were heard as low as 6¼c., with the general range of prices being 6½c. to 6¾c.

Caustic Soda:—Considerable speculation is rife as to what the actual situation of this product may be, owing to the peculiar movement of late. However, most factors concede that its position is gradually weakening, particularly the solid material, while the ground seemingly maintains a more firm standing. Sales of the solid material are passing at some low levels, in some instances at $4. Most factors now offer the 76 per cent solid at from $4.15 to $4.25, while the ground material is quoted at from $5.15 to $5.25.

Bicarbonate of Soda:—This market has developed a more steady tone and prices that have been soaring seemingly reached such an unusual mark that buyers were not disposed to meet. Consequently stocks have accumulated and prices declined from $4.40 to $4.25, which is still considered rather high.

Quinine Sulphate:—The Java brand, that has commanded considerable attention, also developed an easier position, but stocks are reported to be none too liberal in supply. Quotations generally heard range from $1.04 to $1.05.

Citric Acid:—Buyers have been showing very little interest at the close and prices therefore have declined from $1.23 to $1.15. Spot prices are now quoted at from $1.15 to $1.16 for the crystal material, and the powdered is offered at $1.10.

Yellow Prussiate of Potash:—There has been a continued depreciation in price, with material liberally offered in many directions. Buyers have been showing very little interest in the material, in spite of the unusually cheap offerings, some being as low as 90c., while other quotations range from 95c. to $1.

COAL TAR PRODUCTS:—During the interval no important price changes were noted for most of the intermediates, and where some were effected they were inclined upward. Trading in general has been rather quiet, but in view of this fact most of the products are in scarce supply. Paraamidophenol is one of the items which command considerable interest and may be safely classed as the feature of the products that come under this heading. Paraphenylenediamine is also in strong demand and stocks are reported to be in a somewhat depleted condition, while the position of paranitraniline is a trifle easier in stocks.

Phenol:—A rather firm situation prevails for this material, although the pronounced demand that has been in evidence for export purposes has slackened up considerably, particularly trading in the Far East. Local requirement is rather strong and trading is of sufficient volume to keep the market firm. Material with affidavit attached is held at 2c. more than for that of more recent manufacture.

Benzol:—Nothing of an important character has developed in this market. The item maintains a rather firm position and trading is of sufficient volume to take the slack off the market. Available material is fully in proportion to the current demand. Prices for the product in tank cars are subject to no change, though a slight increase is noted for drum material.

Metatolulenediamine:—Very little of the product is being offered; however, the consumption demand is not pressing, and in view of this fact the situation is being fairly well met. Prices are quotably unchanged.

Para Amidophenol:—There has been a continued depreciation in stocks and some important factors state they are in no position to offer, other than in occasional small quantities. Both the base material and H.C.L. are in firm demand, but quotations generally heard indicate no material change in prices.

Benzidine:—The only pronounced interest in this item is for the base material, which is being purchased quite freely for export purposes, while the local consumption is rather slow. The sulphate is more or less neglected with very little buying interest noted. Neither of the items has been affected by price changes.

Saccharines:—A peculiar situation continues to persist in this market, with the prospects small for any activity at the moment. A recent meeting held in New York City for the purpose of encouraging more interest in the item has apparently developed nothing particularly favorable up to the present writing. Prices have declined $1 to $2 and as much as $3 in some instances for both the soluble and insoluble, which are now on a parity.

H. Acid:—Inquiry for this material continues to be very persistent and trading therefore is active. However, most factors in this line still report stocks very scarce, although more frequent offerings appear on the market. Prices are quotably unchanged and remain at firm levels.

Aniline Oil:—Due to the strong demand that has been prevailing for this material during the past few weeks, most directions state that stocks are in a depleted condition and very few spot offerings are now heard. A general advance in price of 1c. to 2c. has been made.

Dinitrophenol:—Offerings of this material for civilian consumption are no easier and the occasional lots which appear in the resale market originate considerable interest. But these are held at rather high prices, which apparently does not curtail trading.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET NOV. 8, 1918

Acetic anhydride		lb.	1.60	—	1.85
Acetone		lb.	.25½	—	.25¾
Acid, acetic, 28 per cent		cwt.	5.96	—	6.11
Acetic, 56 per cent		cwt.	10.76	—	10.87
Acetic, glacial, 99½ per cent., carboys		cwt.	19.00	—	19.20
Boric, crystals		lb.	.13½	—	.15
Citric, crystals		lb.	1.10	—	1.15
Hydrochloric, C. P		lb.	Nominal		
Hydrofluoric, 30 per cent, in barrels		lb.	.08	—	.08½
Lactic, 44 per cent		lb.	.15	—	.16
Lactic, 22 per cent		lb.	.06	—	.07
Molybdic, C. P		lb.	6.90	—	7.40
Nitric, 36 deg		lb.	Nominal		
Nitric, 42 deg		lb.	.08½	—	.10
Oxalic, crystals		lb.	.40	—	.43
Phosphoric, 47-50 per cent paste		lb.	.07½	—	.10
Phosphoric, ref. 50 per cent		lb.	.35	—	.40
Picric		lb.	.75	—	.85
Pyrogallic, resublimed		lb.	3.25	—	3.50
Sulphuric, 60 deg		ton	16.00	—	....
Sulphuric, 66 deg		ton	25.00	—	....
Sulphuric, oleum (Fuming), tank cars		ton	60.00	—	65.00
Tannic, U. S. P., bulk		lb.	1.40	—	1.50
Tartaric, crystals		lb.	.86	—	.95
Tungstic, per lb. of W		lb.	1.70	—	1.75
Alcohol, sugar cane, 188 proof		gal.	4.91	—	....
Alcohol, wood, 95 per cent		gal.	.91½	—	.92
Alcohol, denatured, 180 proof		gal.	.68	—	.69
Alum, ammonia lump		lb.	.06	—	.06½
Alum, chrome ammonium		lb.	.18	—	.19
Alum, chrome potassium		lb.	.20	—	.22
Alum, chrome sodium		lb.	.12½	—	.13
Alum, potash lump		lb.	.09½	—	.10
Aluminium sulphate, technical		lb.	.02	—	.02½
Aluminium sulphate, iron free		lb.	.03¾	—	.04
Ammonia aqua, 26 deg., carboys		lb.	.08½	—	.09
Ammonia, anhydrous		lb.	Nominal		
Ammonium carbonate		lb.	.12	—	.13
Ammonium nitrate		lb.	(Fixed Price)		.15
Ammonium, sulphate domestic		lb.	.07¾		.08
Amyl acetate		gal.	5.30	—	5.35
Arsenic, white		lb.	.09¾	—	.13
Arsenic, red		lb.	.65	—	.70
Barium carbonate, 99 per cent		ton	80.00	—	90.00
Barium carbonate, 97-98 per cent		ton	65.00	—	67.00
Barium chloride		ton	70.00	—	80.00
Barium sulphate (Blanc Fixe, Dry)		lb.	.04½	—	.05
Barium nitrate		lb.	.12	—	.14
Barium peroxide, basis 70 per cent		lb.	.30	—	.32
Bleaching powder, 35 per cent chlorine		lb.	.06½	—	.07
Borax, crystals, sacks		lb.	.08¼	—	.08¾
Brimstone, crude		ton	65.00	—	70.00
Bromine, technical		lb.	.75	—	....
Calcium, acetate, crude		lb.	.04	—	.05
Calcium, carbide		lb.	.16	—	.17½
Calcium chloride, 70-75 per cent, fused, lump		ton	22.00	—	24.00
Calcium peroxide		lb.	1.50	—	1.70
Calcium phosphate		lb.	.22	—	.23
Calcium sulphate, 98-99 per cent		lb.	.09	—	.09½
Carbon bisulphide		lb.	.08	—	.09
Carbon tetrachloride, drums		lb.	.60	—	.70
Carbonyl chloride (phosgene)		lb.	1.10	—	1.50
Caustic potash, 88-92 per cent		lb.	.67	—	.72
Caustic soda, 76 per cent	100	lb.	4.40	—	4.45
Chlorine, liquid (Government Purchase)		lb.	(Fixed Price)		.07½
Cobalt oxide		lb.	1.60	—	1.65
Copperas		lb.	.02¼	—	.02½
Copper carbonate		lb.	.30	—	.31
Copper cyanide		lb.	.75	—	.78
Copper sulphate, 99 per cent, large crystals		lb.	.09¼	—	.09¾
Cream of tartar, crystals		lb.	.75	—	.85
Epsom salt, bags, U.S.P	100	lb.	3.62½	—	3.90
Formaldehyde, 40 per cent		lb.	.16¼	—	....
Glauber's salt		lb.	.02¼	—	.03
Glycerine, bulk, C. P		lb.	.63	—	.65
Iodine, resublimed		lb.	4.25	—	4.30
Iron oxide		lb.	.13	—	.15
Lead acetate, white crystals		lb.	.17	—	.17½
Lead arsenate (Paste)		lb.	.15	—	.18
Lead nitrate		lb.	Nominal		
Litharge, American		lb.	.12	—	.14
Lithium carbonate		lb.	1.50	—	2.05
Magnesium carbonate, technical		lb.	.16	—	.17
Nickel salt, single		lb.	.14	—	.15
Nickel salt, double		lb.	.12	—	.13
Phosgene (see Carbonyl chloride)		lb.	1.10	—	1.50
Phosphorus, red		lb.	1.00	—	1.15
Phosphorus, yellow		lb.	1.10	—	1.20
Potassium bichromate		lb.	.45	—	.46
Potassium bromide granular		lb.	1.25	—	1.26
Potassium carbonate calcined, 85-90 per cent		lb.	.38	—	.40
Potassium chlorate, crystals		lb.	.38	—	.40
Potassium cyanide, 98-99 per cent		lb.	.60	—	.70
Potassium iodide		lb.	3.75	—	3.80
Potassium muriate, 80-85 p. c. basis of 80 p. c		ton	300.00	—	350.00
Potassium nitrate		lb.	.27	—	.31
Potassium permanganate, U. S. P		lb.	1.85	—	2.00
Potassium prussiate, red		lb.	2.30	—	2.50
Potassium prussiate, yellow		lb.	.95	—	1.05
Potassium sulphate, 90-95 p. c. basis 90 p. c		ton	Nominal		
Rochelle salts		lb.	.47	—	.48
Salammoniac, gray gran		lb.	Nominal		
Salammoniac, white gran		lb.	.22	—	.24
Sal soda	100	lb.	1.40	—	1.65
Salt cake		ton	18.00	—	20.00
Silver cyanide, based on market price of silver		oz.	....	—	....
Silver nitrate		oz.	.63½	—	.64
Soda ash, 58 per cent, light, flat (bags)	100	lb.	2.65	—	....
Soda ash, 58 per cent, dense, flat	100	lb.	3.75	—	3.80
Sodium acetate		lb.	Nominal		
Sodium bicarbonate, domestic		lb.	.04	—	.04¼
Sodium bicarbonate, English		lb.	....	—	....
Sodium bichromate		lb.	.21½	—	.22½
Sodium bisulphite, powd		lb.	.12	—	.14
Sodium chlorate		lb.	.25	—	.25½
Sodium cyanide		lb.	.30	—	.35
Sodium fluoride, commercial		lb.	.17	—	.18
Sodium hyposulphite		lb.	2.80	—	3.00
Sodium molybdate, per lb. of Mo		lb.	2.50	—	....
Sodium nitrate, 95 per cent	100	lb.	4.12	—	5.00
Sodium nitrite		lb.	.27	—	.30
Sodium peroxide		lb.	.35	—	.45
Sodium phosphate		lb.	.04	—	.04½
Sodium prussiate, yellow		lb.	.39	—	.40
Sodium silicate, liquid (60 deg.)		lb.	.04½	—	.05
Sodium sulphide, 30 per cent, crystals		lb.	.07¾	—	.08½
Sodium sulphide, 60 per cent, fused	100	lb.	.10½	—	.11½
Sodium sulphite		lb.	.05½	—	.06
Strontium nitrate		lb.	.25	—	.30
Sulphur chloride, drums		lb.	.07½	—	.09
Sulphur dioxide, liquid, in cylinders		lb.	.15	—	.40
Sulphur, flowers, sublimed	100	lb.	4.35	—	4.50
Sulphur, roll	100	lb.	3.70	—	3.85
Sulphur, crude		ton	65.00	—	70.00
Tin bichloride, 50 deg		lb.	.28	—	.29
Tin oxide		lb.	Nominal		
Zinc carbonate		lb.	.18	—	.20
Zinc chloride		lb.	.15	—	.15½
Zinc cyanide		lb.	Nominal		
Zinc dust, 350 mesh		lb.	.13¾	—	.14
Zinc oxide, American process XX		lb.	.12¾	—	.14
Zinc sulphate		lb.	.04¾	—	.06½

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.22	—	.27
Benzol, 90 per cent	gal.	.25	—	....
Toluol, in tank cars	gal.	(Fixed Price)		1.50
Toluol, for non-military use, in drums	gal.	(Fixed Price)		1.55
Xylol, pure, water white	gal.	.45	—	.55
Solvent naphtha, water white	gal.	.18	—	.25
Solvent naphtha, crude, heavy	gal.	.12	—	.15
Creosote oil, 25 per cent	gal.	.45	—	.55
Dip oil, 20 per cent	gal.	.30	—	.32
Pitch, various grades	ton	8.00	—	20.00
Carbolic acid, crude, 95-97 per cent	lb.	1.05	—	1.10
Carbolic acid, crude, 50 per cent	lb.	.60	—	.65
Carbolic acid, crude, 25 per cent	lb.	.35	—	.38
Cresol, U. S. P	lb.	.19	—	.20

Intermediates, Etc.

Alpha naphthol, crude	lb.	1.00	—	1.10
Alpha naphthol, refined	lb.	1.50	—	1.60
Alpha naphthylamine	lb.	.55	—	.60
Aniline oil, drums extra	lb.	.30	—	.32
Aniline salts	lb.	.43	—	.45
Anthracene, 80 per cent	lb.	Nominal		
Benzaldehyde (f.f.c.)	lb.	4.25	—	4.50
Benzidine, base	lb.	1.75	—	1.85
Benzidine, sulphate	lb.	1.40	—	1.45
Benzoic acid, U. S. P	lb.	3.00	—	3.10
Benzoate of Soda, U. S. P	lb.	2.90	—	3.00
Benzyl chloride	lb.	2.45	—	2.50
Beta naphthol benzoate	lb.	10.00	—	12.00
Beta naphthol, sublimed	lb.	.75	—	.85
Beta naphthylamine, sublimed	lb.	2.65	—	....
Dichlor benzol	lb.	.15	—	.20
Diethylaniline	lb.	4.00	—	4.50
Dinitro benzol	lb.	.36	—	.38
Dinitrochlorbenzol	lb.	.40	—	.45
Dinitronaphthaline	lb.	.55	—	.60
Dinitrotoluol	lb.	.65	—	.75
Dinitrophenol	lb.	.55	—	.60
Dimethylaniline	lb.	.73	—	.75
Diphenylamine	lb.	1.00	—	1.10
H-acid	lb.	3.25	—	3.50
Metaphenylenediamine	lb.	1.85	—	2.05
Monochlorbenzol	lb.	.17	—	.20½
Naphthalene, flake	lb.	.09	—	....
Naphthalene, balls	lb.	.11	—	.12¾
Naphtionic acid, crude	lb.	1.20	—	1.30
Naphthylamin-di-sulphonic acid	lb.	1.00	—	1.10
Nitro naphthaline	lb.	.45	—	.50
Nitro toluol	lb.	.55	—	.60
Ortho-amidophenol	lb.	6.50	—	7.00
Ortho-dichlor-benzol	lb.	.15	—	.20
Ortho-toluidine	lb.	1.00	—	1.10
Ortho-nitro-toluol	lb.	.75	—	.85
Para-amidophenol, base	lb.	4.50	—	....
Para-amidophenol, H. C. L	lb.	4.25	—	5.00
Para-dichlor-benzol	lb.	.15	—	.20
Paranitraniline	lb.	1.80	—	1.95
Para-nitro-toluol	lb.	1.50	—	1.60
Paraphenylenediamine	lb.	4.00	—	4.50
Para toluidine	lb.	2.25	—	2.50
Phthalic acid anhydride	lb.	4.25	—	5.00
Phenol, U. S. P	lb.	.42	—	.47
Resorcin, technical	lb.	4.50	—	5.00
Resorcin, pure	lb.	7.50	—	8.00
Salicylic acid	lb.	.85	—	....
Salol	lb.	1.50	—	2.00
Sulphanilic acid, crude	lb.	.31	—	.33
Toluidine	lb.	2.50	—	3.00
Toluidine-mixture	lb.	.85	—	.90

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	4.00	—	....
Corning, Ohio	bbl.	2.85	—	....
Somerset, Ky	bbl.	2.60	—	....
Wooster, Ohio	bbl.	2.68	—	....
Indiana	bbl.	2.28	—	....
Illinois	bbl.	2.42	—	....
Oklahoma and Kansas	bbl.	2.25	—	....
Caddo, La., light	bbl.	2.25	—	....
Corsicana, Tex., light	bbl.	2.25	—	....
California	bbl.	1.24	—	1.57
Gulf Coast	bbl.	1.35	—	....
Mexican	bbl.	1.90	—	....

Fuel Oil

New York	gal.	.15	—	....
Philadelphia	gal.	.10½	—	....
Baltimore	gal.	.07¾	—	.15½
Pittsburgh	gal.	.07½	—	.10
Texas	bbl.	1.85	—	2.35
Los Angeles	bbl.	1.65	—	....

Gasoline (Wholesale)

New York, motor	gal.	.24½	—	....
Gas machine	gal.	.41½	—	....
72-76 degrees	gal.	.33½	—	.39½
70-72 degrees	gal.	.32	—	.37½
67-70 degrees	gal.	.30½	—	.36½
Pittsburgh, motor	gal.	.25½	—	....
Chicago, motor	gal.	.22½	—	.23
Oklahoma, motor	gal.	.21½	—	....
San Francisco, motor	gal.	.20½	—	....

Paraffine Waxes

Crude, 103 to 105 deg. m.pt	lb.	.08½	—	.09
Crude, 118 to 120 deg. m.pt	lb.	.09½	—	.10
Crude, 124 to 126 deg. m.pt	lb.	.10	—	....
Refined, 120 deg. m.pt	lb.	.13½	—	....
Refined, 128 deg. m.pt	lb.	.14	—	....
Refined, 135 deg. m.pt	lb.	.16	—	.16½
Ozokerite, brown	lb.	.75	—	.80
Ozokerite, green	lb.	.85	—	.90

Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	.24	—	.25
Cylinder, light	gal.	.45	—	.50
Cylinder, dark	gal.	.39	—	.43
Paraffine, high viscosity	gal.	.40	—	.41
Paraffine, 0.903 sp. gr	gal.	.36	—	.38
Paraffine, 0.885 sp. gr	gal.	.26	—	.28

Flotation Oils

(Prices at New York unless otherwise stated)

Pine oil, crude, f. o. b. Florida	gal.	.44	—	....
Pine oil, steam-distilled, sp. gr. 0.925-0.940	gal.	.58	—	.60
Pine oil, destructively distilled	gal.	.58	—	.60
Pine-tar oil, sp. gr. 1.02-1.035	gal.	.35	—	....
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.42	—	....
Pine-tar oil, ref., light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37	—	....
Pine-tar oil, ref., heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.28	—	....
Pine-tar oil, ref., thin, sp. gr. 1.060-1.080	gal.	.32	—	....
Turpentine, crude, sp. gr. 0.870-0.900	gal.	.45	—	....
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990	gal.	.23	—	....
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08	gal.	.23	—	....
Wood creosote, ref., f.o.b. Florida	gal.	.31	—	....

Naval Stores

Rosin A-E barrel	280 lb.	15.35	—	15.65
Rosin F-I	280 lb.	15.65	—	16.00
Rosin K-N	280 lb.	16.00	—	17.00
Rosin WG-W	280 lb.	17.00	—	17.50
Spirits of turpentine	gal.	.73	—	....
Wood turpentine, steam distilled	gal.	.62	—	.65
Wood turpentine, destructively distilled	gal.	.58	—	....
Pitch ... bbl.	200 lb.	8.00	—	....
Tar, kiln dried	280 lb.	13.00	—	13.50
Retort tar	280 lb.	14.00	—	14.50
Rosin oil, first run	gal.	.80	—	....
Second run	gal.	.83	—	....
Third run	gal.	.88	—	....
Fourth run	gal.	.98	—	....

Vegetable Oils

Castor oil	lb.	.34	—	.38
China wood oil	lb.	.27	—	.28
Cocoanut oil	lb.	.16½	—	.22
Corn oil	lb.	.18	—	....
Cottonseed oil, crude	lb.	.20	—	.22
Linseed oil, raw, cars	gal.	1.81	—	1.86
Olive oil	gal.	4.25	—	4.50
Peanut oil, crude	lb.	.18	—	.22
Soya bean oil, Manchuria	lb.	.17	—	.18½

Glues

Extra white	lb.	.36	—	.45
Cabinet	lb.	.31	—	.40
Brown foot stock	lb.	.18	—	.22
Fish glue, 50-gal. barrels	gal.	1.00	—	1.80

Miscellaneous Materials

Barytes, floated, white, foreign	ton	Nominal		
Barytes, floated, white, domestic	ton	33.00	—	36.00
Beeswax, white, pure	lb.	.63	—	.65
Beeswax, unbleached	lb.	.43	—	.48
Blanc fixe	lb.	.05½	—	....
Casein	lb.	.17½	—	.30
Ceylon graphite	lb.	.07½	—	.25
Chalk, light, precipitated, English	lb.	.04½	—	.06
China clay, imported, lump	ton	20.00	—	40.00
China clay, domestic, lump	ton	15.00	—	22.50
Feldspar	ton	8.00	—	12.00
Fluorspar, gravel, f.o.b. mines	ton	28.00	—	40.00
Fluorspar, washed, powdered	ton	90.00	—	....
Fuller's earth, powdered	100 lb.	1.50	—	2.00
Japan wax	lb.	.26	—	.27
Mexican graphite	ton	60.00	—	75.00
Madagascar graphite	lb.	.10	—	.15
Orange shellac	lb.	.72	—	.80
Pumice stone	lb.	.04	—	.08
Red lead, dry, carloads	100 lb.	.11½	—	.11½
Soapstone	ton	15.00	—	25.00
Stearic acid, 120 deg. m.pt	lb.	.13		.14
Stearic acid, 140 deg. mpt	lb.	.18	—	.19
Talc, American, white	ton	20.00	—	40.00
White lead, dry	lb.	.09½	—	.10½

Refractories, Etc.

(F.O.B. Works)

Chrome brick	net ton	175.00	—	....
Chrome cement	net ton	75.00	—	....
Clay brick, first quality fireclay	per 1000	50.00	—	55.00
Clay brick, second quality	per 1000	35.00	—	40.00
Magnesite, raw	ton	30.00	—	35.00
Magnesite, calcined, powdered	ton	50.00	—	65.00
Magnesite, dead burned	net ton	50.00	—	60.00
Magnesia brick, 9x4½x2½	net ton	110.00	—	125.00
Silica brick	per 1000	50.00	—	60.00

Ferroalloys

Ferrocarbontitanium, 15-18 per cent, carloads, f. o. b. Niagara Falls, N. Y	ton	200.00	—	250.00
Ferrocerium	lb.	15.00	—	30.00
Ferrochromium, per lb. of Cr	lb.	.30	—	.40
Ferromanganese, domestic, 70 per cent basis	ton	250.00	—	....
Ferromanganese, English	ton	325.00	—	....
Spiegeleisen (16-18%)	ton	75.00	—	....
Ferromolybdenum, per lb. of Mo	lb.	3.50	—	4.50
Ferrosilicon, 75 per cent, f.o.b. N. Y	ton	....	—	....
Ferrosilicon, 50 per cent, contract	ton	153.00	—	160.00
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh	lb.	2.35	—	2.40
Ferrouranium, f.o.b. works, per lb. of U	lb.	7.50	—	....
Ferrovanadium, f.o.b. works	lb.	....	—	....

Ores and Semi-finished Products

Chrome ore, 45 per cent minimum, f.o.b. Cal. per unit	ton	1.50	—	1.55
Chrome ore, 43 per cent and over, New York, per unit	ton	1.40	—	....
Coke	ton	6.00	—	7.00
Manganese ore, 48 per cent and over, per unit	ton	1.20	—	....
Manganese ore, chemical	ton	80.00	—	100.00
Molybdenite, per lb. of MoS_2	lb.	1.25	—	1.50
Tungsten, Scheelite, per unit of WO_3	ton	25.50	—	....
Tungsten, Wolframite, per unit of WO_3	ton	24.00	—	....
Uranium oxide, 96%	lb.	3.25	—	3.60
Vanadium pentoxide, 99%	lb.	10.50	—	....
Pyrites, foreign	unit	.17	—	....
Pyrites, domestic	unit	.28	—	.30½

Plant Supplies

BUILDING MATERIALS

Common clay bricks	M	13.00	—	14.00
Hollow tile, 4 x 12 x 12	M	60.00	—	....
Hollow tile, 12 x 12 x 12	M	170.00	—	....
Lime	ton	16.50	—	....
Portland cement	bbl.	2.59	—	....
Single glass (82-lb.), 10 x 26-16 x 24		21.00	—	27.00
Double glass (164 lb.), 10 x 26-16 x 29		31.00	—	39.00
Yellow pine lumber	M	39.00	—	45.00
Fir lumber	M	38.00	—	53.00
Hemlock	M	24.50	—	40.00
Tarred felt (14-lb.sq.)	ton	68.00	—	....
Roofing pitch	ton	27.00	—	....
Asphalt coated roofing (35-55-lb.sq.)	sq.	1.60	—	2.45
Slate surfaced asphalt shingles	sq.	5.25	—	5.50
Corrugated galvanized iron	ton	109.00	—	127.00
Putty	100 lb.	6.25	—	....
Red oxide (Ppte. Copperas)	100 lb.	15.00	—	20.00
Native red oxide	100 lb.	3.25	—	8.00
Red metallic paint	100 lb.	1.20	—	1.50
White lead in oil	100 lb.	11.84	—	14.00
Red lead in oil	100 lb.	12.28	—	14.50
Zinc oxide (dry)	100 lb.	13.00	—	14.50
Zinc oxide—leaded	100 lb.	9.00	—	10.00
Yellow ochre	100 lb.	1.50	—	10.00
Ultra marine blue	100 lb.	14.00	—	50.00
Prussian blue	100 lb.	135.00	—	150.00
Chrome green	100 lb.	40.00	—	70.00
Paris green	100 lb.	43.00	—	49.00
Mineral black	100 lb.	1.75	—	2.25
Powdered bone black	100 lb.	5.50	—	12.00
Lampblack	100 lb.	15.00	—	45.00
Gas carbon	100 lb.	16.00	—	25.00
Mexican petroleum pitch	100 lb.	1.00	—	2.00
Gilsonite	100 lb.	2.00	—	2.50
Coal tar pitch	100 lb.	.60	—	1.25

STRUCTURAL IRON

Blue annealed sheet iron	ton	84.00	—	89.00
Black sheet iron	ton	96.00	—	104.00
Galvanized iron	ton	105.00	—	135.00
Tern plate, 8-lb. coating	ton	150.00	—	....
Tern plate, 15-lb. coating	ton	177.50	—	....
Tern plate, 25-lb. coating	ton	200.00	—	....
Tern plate, 40-lb. coating	ton	240.00	—	....
Tin plate, prime	ton	155.00	—	....
Tank plates	ton	65.00	—	70.00
Beams, channels, angles, T's, Z's	ton	60.00	—	65.00
Rivets	ton	88.00	—	92.00
Steel pipe, ½ to 3-inch	ton	51.00	—	....
Bar iron and steel	ton	60.00	—	70.00
Chain (1 inch proof coil)	ton	150.00	—	....
Nails, bolts, nuts, washers	ton	70.00	—	80.00
Tool steels, special alloys	ton	300.00	—	500.00
Bessemer pig iron	ton	36.60	—	....
Bessemer steel	ton	47.50	—	....
No. 2 foundry	ton	37.90	—	....
Steel billets (4 x 4)	ton	47.50	—	....

POWER HOUSE SUPPLIES

Steam packing, rubber duck	lb.	.99	—	1.10
Asbestos, high pressure	lb.	1.76	—	....
Asbestos, wired	lb.	1.30	—	....
Asbestos, graphited braid	lb.	1.21	—	....
Asbestos, wick	lb.	.75	—	....
Rubber, sheet	lb.	.66	—	....
Cup grease	lb.	.07	—	....
Transmission grease	lb.	.07	—	....
Axle grease	lb.	.04½	—	....
Gear grease	lb.	.04½	—	....
Cotton waste	lb.	.08½	—	.13
Hose, underwriters, 2½ in	ft.	.75	—	....
Hose, air, ¾ in	ft.	.30	—	.60

INDUSTRIAL

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

CHOCTAW POINT.—The Consumers Dye Woods Products Co., Mobile, will increase the capacity of its plant.

Arizona

FLAGSTAFF.—The Navajo Copper Co. will build a leaching plant having a daily capacity of 100 tons. G. A. McCollough, manager.

KINGMAN.—The Industrial Finance Co., 50 East 42nd St., New York City, N. Y., will build a 40 x 140 ft. plant for the production of fiber and fiber products from the Yucca plant.

PATAGONIA.—The Mowry Mining Co. will build a new concentration plant at its local mining properties.

TUCSON.—The Pima County Smelting Co. will build a large reduction plant to provide for increased operations. Address C. M. Garrison.

Arkansas

BATESVILLE.—Dr. Tooker will build a manganese washing plant here and is in the market for a log washer, belts, power, jig irons, pulleys and shafting.

California

COVINA.—The city has awarded the contract for the installation of a chlorination plant at the intake of the city reservoir supplying water for domestic use, to the California Jewell Filter Co. Estimated cost, $8000.

MARE ISLAND.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., plans to build an oxy-acetylene generating plant, under Specification No. 3522, noted Oct. 15.

MARTINEZ.—The Shell Oil Co. will build an addition to its refinery. Estimated cost, $80,000.

MELROSE (Oakland P. O.)—The National Lead Co. will build several reinforced-concrete factory buildings here. Estimated cost, $300,000. H. A. Broberg, 485 California St., San Francisco, is preparing plans.

SAN DIEGO.—L. M. Cox, Commandant, 12th Naval District, has awarded the contract for the construction of seven air school buildings, on North Island, to the Los Angeles Planing Mill Co., 1812 Industrial St., Los Angeles. Project includes the construction of laboratories, oil storage and reclaiming buildings, etc. Total estimated cost, $58,391.

SAN FRANCISCO.—The Bureau of Foreign and Domestic Commerce, 307 Custom House, has information regarding a firm in Russia which is in the market for complete equipment for a sulphate-cellulose mill and a paper factory. Refer to file No. 20200.

Colorado

LEADVILLE.—The Fanny Rawlings Mining Co. will rebuild its surface plant, recently destroyed by fire entailing a loss of $13,000. W. C. Frost, superintendent.

Connecticut

PLAINVILLE.—The Trumbull Electric Manufacturing Co., Woodward Ave., has awarded the contract for the construction of a sewage disposal plant to A. D. Marco, Southington. Estimated cost, $40,000. Noted Nov. 15.

Delaware

WILMINGTON.—The E. I. du Pont de Nemours Co. will build a two-story, 45 x 50 ft. addition to its local organic laboratory. Estimated cost, $25,000.

Kansas

TREECE.—Col & Matthews, Picher, Okla., will remove its plant from Picher to Treece and remodel same. The company is in the market for roofing, cement, mill hardware, pipe, pump, sludge tables, belts, concrete and lumber. Estimated cost, $40,000. J. H. Kleinfelter, superintendent.

Maryland

BALTIMORE.—The United States Emergency Fleet Corporation, Housing Department, 253 Broad St., Philadelphia, Penn., will build a sewage disposal plant here. Estimated cost, $50,000. Norton, Bird & Whitman, Munsey Building, engineers.

Massachusetts

HINGHAM.—The Bureau of Yards and Docks, Navy Department, Washington, D. C., will build a TNT plant here. Estimated cost, $150,000.

Michigan

DETROIT.—The Construction Division of the War Department, Washington, D. C., will build a sulphuric acid plant here. Estimated cost, $1,500,000.

DETROIT.—The Cummings & Moore Graphite Co., 672 Water St., has awarded the following contracts for the construction of a factory building: carpentry, to David J. Osgood, 220 West Elizabeth St.; masonry, to Stokes & Whittingham, Penobscot Building. Noted Oct. 31.

Minnesota

WORTHINGTON.—The State Board of Control will build a filter plant having a capacity of 80,000 gal. and a pumping plant; filter equipment will be installed in same. D. F. Mullen, secretary. L. P. Wolfe, 1000 Guardian Life Building, St. Paul, engineers.

Missouri

JOPLIN.—The Badger Mining Co. has awarded the contract for the construction of a concentration plant, to Edgar Foster. Estimated cost, $56,000.

JOPLIN.—The Freehold Oil & Gas Co. has taken over two leaseholds in the Waco-Lawton field, and will build a 200-ton mill on each tract. W. S. Marquiss, Webb City, manager.

KANSAS CITY.—The Jensen-Salsberry Laboratories, 1320 Main St., will build a three-story, 56 x 128 ft. rein.-forced concrete and brick laboratory. Estimated cost, $65,000. E. O. Brostrom, 212 Reliance Building, architect. Noted June 20.

New Jersey

CAPE MAY.—The Bureau of Yards & Docks, Navy Dept., Washington, D. C., will receive bids until Nov. 11 for the construction of a blacksmith, coppersmith and electric shop, Specification No. 3051. Estimated cost, $9000.

CLAREMONT.—The Standard Oil Co., 26 Broadway, New York City, will build a reinforced-concrete filter and tank house at its Eagle works here.

JERSEY CITY.—The Davis-Bournonville Co., Van Wagenen Ave., manufacturer of acetylene goods, will build an addition to its plant. Estimated cost, $75,000.

JERSEY CITY.—The Van Dyke Chemical Co., 57 Wilkinson Ave., will rebuild its plant recently destroyed by fire entailing a loss of $10,000.

NEWARK. — The Butterworth-Judson Corporation, Avenue R, will install a large quantity of new nitrating equipment to replace the chemical stoneware now in use.

NEWARK.—The Oxweld Acetylene Co., 640 Frelinghuysen Ave., has awarded the contract for the construction of a three-story, 42 x 100 ft. factory addition to Fred Kilgus, 13 South 6th St. Estimated cost, $49,800. Noted Oct. 31.

New York

BROOKLYN.—McKesson & Robins, 91 Fulton St., New York City, will build a two-story, 60 x 80 ft. factory addition for the manufacture of drugs on North 11th and Perry St. Estimated cost, $8500. T. Englehardt, 905 Broadway, architect.

BROOKLYN.—The Ohio City Oil Co., Varick Ave., has awarded the contract for the construction of alterations to its plant, to the William Kennedy Construction Co., Montague St. Estimated cost, $10,000.

BROOKLYN.—The Standard Oil Co., 26 Broadway, New York City, has awarded the contract for the construction of an addition to its plant at the Gowanus Canal and 2nd St., to the R. W. Smith Contracting Co., 368 Lexington Ave., New York City. Estimated cost, $25,000.

BUFFALO.—The Aluminum Castings Co., 2800 Harvard Ave., Cleveland, Ohio, has awarded the contract for the construction of a three-story laboratory at 1850 Elmwood Ave., to the Schaaf Construction Co., Buffalo. Estimated cost, $20,000. Noted Nov. 15.

BUFFALO.—The Donner Steel Co., 375 Abbott Road, will build a concrete and steel laboratory and engineering office. Estimated cost, $35,000.

BUFFALO.—The Prest-O-Lite Co., 206 Amsterdam Ave., New York City, has awarded the contract for the construction of a plant which consists of 4 units, to John W. Cowper Co., Fidelity Building. Estimated cost, $100,000.

NEW YORK.—The John Trageser Steam & Copper Works, 447 West 26th St., has awarded the contract for the construction of a four-story, concrete and brick factory, to Garret S. Wright, 415 West 24th St. Estimated cost, $20,000.

OTISVILLE.—The Construction Division of the War Department, Washington, D. C., will build an addition to the present laboratory in connection with the additional hospital facilities at the Tuberculosis Hospital here. Total estimated cost, $312,579.

YAPHANK.—The Construction Division of the War Department, Washington, D. C., has awarded the contract for the construction of a sewage disposal plant here, to the Beaver Engineering & Contracting Co., 51 Chambers St., New York City.

North Carolina

ANDREWS.—The Andrews Tanning Co., Lock Haven, Penn., recently organized with $300,000 capital, will build an extract plant here.

Ohio

AKRON.—The Commissioners of Summit County received bids for the construction of a sewage disposal plant for Summit Co. Infirmary buildings, from Koegel, Walsh Construction Co., Akron, $12,768; Herman Fouse, Akron, $15,102; D. Bowers, Akron, $15,468. M. P. Lauer, 425 Ohio Building, engineer. Noted Oct. 31.

ANCHOR.—The United States Government has awarded the contract for the construction of a nitrate plant here, to the George A. Fuller Co., Swetland Building, Cleveland.

ANCHOR.—The Air Nitrates Corporation, 360 Madison Ave., New York City, N. Y., will build the first unit of its new plant here. Estimated cost, $20,000,000, the output to be used for government service exclusively.

CLEVELAND.—The Grasselli Chemical Co., Guardian Building, will rebuild its two-story, 60 x 120 ft. factory, which was recently destroyed by fire. Estimated cost, $50,000.

CLEVELAND.—The Ohio Chemical Co., 1177 Marquette Road, will build a factory on a site it recently purchased. J. H. Shales, secretary.

CLEVELAND.—The Ohio Metal Briquetting Co., 909 Schofield Building, will build a one-story, 54 x 102 ft. factory. Estimated cost, $50,000. Frank Smith, c/o owner, architect.

WILLOUGHBY.—The Construction Division of the War Department, Washington, D. C., will build a medical building and additional barracks, etc., here, for the use of the Chemical Warfare Service. Total estimated cost, $167,670.

Oklahoma

MIAMI.—The Bon-Ami Mining Co. will build a 150-ton concentration plant and is in the market for sludge and slime tables, crushers, boilers, belts, wire cables, jigs, drills, engine, air compressors, lumber, roofing and hoists. Estimated cost, $50,000.

MIAMI.—The Greenback Mining Co. will build a 200-ton concentration plant and is in the market for motors, electric wiring, sludge and slime tables, crushers, air compressors, conveyers, roofing, lumber, engine, jigs, boilers, hoisters and wire cables. Estimated cost, $60,000. T. C. Greenback, superintendent.

ST. LOUIS.—The Lucky Strike Mining Co., Miami, will rebuild its concentration plant recently destroyed by fire and is in the market for mill hardware, mill roofing, lumber, concrete, sludge and slime tables, engine, boilers, pipe, crushers, air compressors, conveyers, belts, wire cables, ore cans, ore cars and track. Estimated cost, $65,000. E. H. Austin, superintendent.

TULSA.—The City Commissioners will install an additional filtration plant and add sufficient facilities to handle from 6,000,000 to 7,000,000 gal. water daily.

Pennsylvania

FRANKLIN.—The Franklin Quality Refining Co., Lamberton Bank Building, will build a new filter house at its local refinery. Estimated cost, $100,000.

MARIETTA.—The Gilliland Laboratories Co. will rebuild its plant here recently damaged by fire.

NOXEN.—The Noxen-Armour Leather Co., Union Stock Yards, Chicago, Ill., has awarded the contract for the reconstruction of its two-story, concrete and brick tanning plant to Westinghouse, Church, Kerr & Co., 37 Wall St., New York City, N. Y. Estimated cost, $500,000.

PHILADELPHIA.—The Keystone Lubricating Co., 21st and Clearfield St., will build a 20 x 225 ft. addition to its plant for the manufacture of grease.

SHARON.—The Sharon Steel Hoop Co., South Irving Ave., will build two additional open hearth furnaces, a by-product coke plant and possibly another blast furnace.

SWEDELAND.—The Rainey-Wood Coke Co. formed by the Allen Wood Iron & Steel Co. and the W. J. Rainey Estate of 52 Vanderbilt Ave., New York City, N. Y., will build a byproduct coke oven plant to produce 1200 tons of coke daily for use in blast furnaces and large quantities of ammonium sulphate and other chemicals.

Texas

BURKBURNET.—D. B. Welty, Cushing, Okla., and associates, will build an oil refinery here having a daily capacity of 2000 barrels, upon site recently purchased.

Utah

SALT LAKE CITY.—The Vipont Mining Co. will build a 250-ton concentration plant in the Ashbrook District of Boxelder County. C. A. Phillips, president.

Virginia

NORFOLK.—The Bureau of Yards & Docks, Navy Department, Washington, D. C., will soon award the contract for the construction of a galvanizing plant, oxy-acetylene and generating plant here. Estimated cost, $110,000. Noted Oct. 31.

RICHMOND.—The Southern Oil Products Co., recently incorporated with $50,000 capital, will establish a local plant and is in the market for machinery and equipment for the manufacture of oil specialties. The initial installation is estimated to cost $10,000. W. H. Warren, 701 American National Bank Building, president.

Washington

PUGET SOUND.—The Bureau of Supplies & Accounts, Navy Department, Washington, D. C., received bids for the construction of acetylene and oxy-hydrogen generating plant, Schedule No. 1958, Class 11, from Alexander Milburn Co., Baltimore, Md., $900 (part bid); Burdett Manufacturing Co., 309 St. John St., Chicago, Ill., $38,892; Davis Bournonville Co., Van Wagenen Ave., Jersey City, N. J., $42,128, alternate, $38,897; International Oxygen Co., 115 Broadway, New York City, N. Y., $44,117, alternate, $53,175.

West Virginia

CHARLESTON.—The West Virginia Water & Electric Co., 131 Summers St., has awarded the contract for remodeling and building additions to its existing plant, to the Charleston Concrete Construction Co., Charleston.

MARTINSBURG.—The National Shale Brick Co., recently incorporated with $250,000 capital stock, will build three brick plants. Address H. H. Emmert, Martinsburg.

WATSON.—The State Board of Control, Clarksburg, will build a sewage-disposal plant here.

Wisconsin

MARINETTE.—The Marinette-Menominee Paper & Pulp Co. has awarded the contract for the construction of a sulphite mill and two towers, to the Northern Boiler & Structural Co., Appleton.

MILWAUKEE.—The Modern Steel Treating Co., 220 Becher St., will rebuild its plant recently destroyed by fire, entailing a loss of $20,000.

WAUWATOSA. — The Northwestern Chemical Co., 61st and State St., has awarded the contract for the construction of a one-story, 48 x 147 ft. chemical plant, to C. A. Kleppe, 1026 1st St., Milwaukee. Estimated cost, $20,000. Noted Oct. 15.

Wyoming

BIG SANDY.—The Producers & Refiners Corporation, 301 California Building, Denver, Colo., will build a casing-head gasoline plant, having a daily capacity of 10,000,000 cu.ft. on their property in the Big Sand Draw Field. T. G. Smith, of the International Trust Co., 17th and California St., Denver, Colo., director.

British Columbia

GRAVES POINT.—The Granby Consolidated Mining, Smelting & Power Co., 718 Granville St., Vancouver, will build a by-products plant. Estimated cost, $1,250,000.

IOCO.—The Imperial Oil Co., Ltd., Cambie and Smythe St., Vancouver, will build an addition to its oil refineries. Estimated cost, $250,000. J. E. Sirdwan, superintendent.

VANCOUVER.—The Drum Lummon Copper Mines, Ltd., 115 Dominion Building, will install a Gibson mill and concentrator in its works at Drum Lummon Bay, Douglas Channel, to have a daily capacity of 36 tons. Estimated cost, $5,000.

Ontario

TORONTO.—The Palmolive Co. of Canada, 64 Natalie St., will build an addition to its plant. Estimated cost, $10,000.

WINDSOR.—The British American Oil Co., Royal Bank Building, Toronto, will build a concrete and steel distributing plant. Estimated cost, $150,000. T. S. Merrill, 25 Woodland St., Detroit, Mich., secretary.

Industrial Notes

THE UNITED FILTERS CORPORATION, of Brooklyn, N. Y., have found it necessary to move to larger quarters. The Eastern works testing laboratory will be in its own building at 355 Cortland Street, Belleville, N. J. and the sales office is now located at 65 Broadway, New York City.

RICKETTS & CO., INC., New York City, formerly of 80 Maiden Lane, announce that, in order to meet increased business requirements they have found it necessary to move to larger offices at 280 Madison Ave. By associating with them Charles E. Wagstaffe Bateson, and Dr. M. L. Hamlin, and by securing the services of T. A. Shegog, formerly assistant professor of chemistry and metallurgy at the Royal College of Science, Dublin, and professor of chemistry and metallurgy for the county of Monmouth, they have placed themselves in a position not only to carry on their mining and metallurgical consulting business on an enlarged scale, but to handle the most varied organic and inorganic manufacturing problems and related chemical work. Small samples for assay or analysis should be sent by parcels post to the office; large samples by express to the laboratories, 7 Dutch Street, New York City.

THE LOCOMOTIVE PULVERIZED FUEL CO. has just received an order from Morris & Co., Chicago, Ill., for equipping its steam power plant at Oklahoma City, Okla., with a complete "Lopulco" system for crushing, drying, pulverizing and burning coal. Native coals are expected to be used together with Texas lignite. The power plant contains seven Edgemoor boilers, having a total of 3100 horsepower, all of which are to be equipped.

THE BARBER-GREENE CO. announces the strengthening of its organization as follows: F. E. Smith, chief engineer, formerly of the engineering department of the Stephens-Adamson Mfg. Co., of the Granby Mining & Smelting Co. and the American Zinc & Chemical Co. Geo. C. Sanford, superintendent, formerly of the Elevator Supplies Co. and of the Otis Elevator Co.

THE FEDERAL DYESTUFF & CHEMICAL CORPORATION of Kingsport, Tenn., has decided to call itself the Union Dyestuff & Chemical Corporation.

Manufacturers' Catalogs

THE W. S. ROCKWELL CO., 50 Church Street, New York, calls attention to two new bulletins. Bulletin 36 illustrates and describes tilting reverberatory melting furnaces for non-ferrous metals in capacities ranging from 500 to 2000 pounds. Bulletin 37 illustrates a type of furnace used for annealing, particularly copper wire and similar products, without oxidation. Figs. 1 and 2 illustrate equipment in an Eastern wire mill; Figs. 3 and 4, an installation at a big copper mining company in Montana. Fig. 5, with the table directly beneath it, is self-explanatory. This installation was made in the West and while the results secured were very good, still it is expected that they will be greatly bettered when the operators become more familiar with the furnace. Copies will be sent to any one who can use them to advantage.

THE PACIFIC TANK & PIPE CO., San Francisco, Calif.: A very attractive 128-page booklet, Catalog No. 12, illustrates and describes the latest improvements and ideas in cyanide plant equipment. Standard dimensions, capacities and weights of tanks which this company can furnish are given, together with the list price of each.

THE SOWERS MANUFACTURING COMPANY, Buffalo, N. Y.: Catalog VI covers the Dopp line of cast-iron seamless steam jacketed kettles, mixers and vacuum pans, which are described and illustrated.

THE J. P. DEVINE CO., Buffalo, N. Y., has just received from the press three bulletins. Bulletin No. 101 illustrates and describes in detail all types of Devine patented vacuum chamber dryers. Bulletin No. 106 deals with single and multiple effect vacuum evaporators, vacuum pans, distilled water evaporators, etc., and Bulletin No. 107 is on high efficiency vacuum pumps, both rotary and slide valve type. In these bulletins the illustrations are photographs showing actual installation of apparatus. Copies of these bulletins will be gladly sent to anyone interested in the types of apparatus described.

THE HANOVIA CHEMICAL & MFG. CO., Newark, N. J., announces a new bulletin, No. 20W, descriptive of the Hanovia Quartz Lamp, a scientifically designed and efficiently practical source of the ultraviolet rays, which are being successfully used in the chemical industry. The bulletin contains facts regarding some of the uses for the lamp and its adaptability.

New Publications

TESTS TO DETERMINE THE RIGIDITY OF RIVETED JOINTS OF STEEL STRUCTURES: Bulletin 104, issued by the Engineering Experiment Station of the University of Illinois, Urbana, Ill.

MAXIMUM BITUMINOUS COAL PRICES, F. O.B. AT THE MINES. Publication No. 4E, published by the United States Fuel Administration, Washington, D. C. These prices were in effect Oct. 7, 1918.

NEW UNITED STATES GEOLOGICAL SURVEY PUBLICATIONS: 1:7, Tin in 1917, by Adolph Knopf. Mineral Resources of the U. S., 1917, Part 1 (pages 63-72), published Sept. 16, 1918; 1:8, Silver, Copper Lead and Zinc in the Central States in 1917, Mines Report, by J. P. Dunlop and B. S. Butler. Mineral Resources of the U. S., 1917, Part 1 (pages 73-130), published Oct. 24, 1918; II:19, Fuller's Earth in 1917, by Jefferson Middleton. Mineral Resources of the U. S., 1917, Part II, (pages 253-255), published Sept. 18, 1918; II:21, Barytes and Barium Products in 1917, by James M. Hill. Mineral Resources of the U. S., 1917, Part II, (pages 285-291), published Oct. 14, 1918. Bulletin 21, of the coöperative mining series entitled, The Manufacture of Retort Coal-Gas in the Central States, Using Low-Sulphur Coal from Illinois, Indiana and Western Kentucky, by W. A. Dunkley and W. W. Odell, is published by the State of Illinois, Dept. of Registration and Education, Division of the State Geological Survey, Urbana, Ill.

NEW BUREAU OF MINES PUBLICATIONS: Tech. Paper 139. Low-Rate Combustion in Fuel Beds of Hand Fired Furnace. By Henry Kreisinger, C. E. Augustine and S. H. Katz; Tech. Paper 186. Methods for Routine Work in the Explosives Physical Laboratory of the Bureau of Mines. By S. P. Howell and J. E. Tiffany; Tech. Paper 192. Production of Explosives in the United States During the Calendar Year 1917, with notes on coal-mine accidents due to explosives and list of permissible explosives tested prior to April 30, 1918. Compiled by Albert H. Fay; Tech. Paper 195. The Tars Distilled from Bituminous Coal in Hand-Fired Furnaces. By S. H. Katz.